



TAMPERE UNIVERSITY OF TECHNOLOGY

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**BUSINESS MODELS FOR SOFTWARE-BASED SERVICES IN  
COMPLEX SYSTEMS**

Master of Science Thesis

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# ABSTRACT

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Manufacturing industry has evolved towards the delivery of complex systems, involving equipment, services and software components. Traditional industrial services are connected to the physical equipment, limiting the possibilities of service offering and thus, the financial benefits of them. It is not rare that services are focused on the maintenance of the customer's equipment or on selling spare parts. Despite this, fiercer competition calls for new differentiation methods and increased customer value. Software-based services enabled by equipment lifecycle data represent a key business opportunity for manufacturing firms in a globalized world.

Previous studies on servitization in the manufacturing industry enabled by product lifecycle data have considered the software tools needed to deliver the services, but the conditions and network tasks in the delivery chain are often overlooked. In the manufacturing industry, the increased centrality of information technology calls for cooperation with more specialized suppliers, and this cooperation is poorly understood. Thus this thesis explores alternative business models for software-based services and the tasks related to the service delivery network, considering the cooperation between manufacturing and software firms. The conditions to enable and successfully promote industrial services based on equipment lifecycle data are also described.

An exploratory study was conducted with four software firms and two manufacturing companies. Interviews took place with employees with diverse managerial positions in different areas, revealing unexploited opportunities for software-based services enabled by equipment lifecycle data. A framework for a triadic cooperation is presented, clarifying the task division between manufacturing and software firms in service delivery. The customers' participation specifics were set aside as this thesis had no access to them and their role specification was limited to the firms' interpretation. It is suggested that a future study is conducted applying the presented suggestions and involving the customer in the process.

## PREFACE

This study allowed me to get an insight of high-tech manufacturing firms in Finland and companies offering different software solutions. I was able to combine my previous IT studies and experience with my newly acquired business perspective to come up with new ideas to develop industrial services. I have also identified the trends in the industry and got an idea of how the future looks like.

The opportunity to write my thesis at TUT came just in the right moment and I am very grateful with my supervisor Miia Martinsuo for her guidance, feedback and support through the writing and research process. Special thanks also go to the company representatives that facilitated my interviews, to the respondents for their valuable input and to all the people in the S4Fleet program that participated in this study.

Thanking all the people that have supported me to reach this point would take a while, but I know you know who you are. After the six chapters in this thesis, I am ready to start writing a new one in my life as a Master of Science!

Tampere, 24.08.2015

Moramay Ocaña Flores

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## ABBREVIATIONS

B2B	Business to business
B2C	Business to customer
BM	Business model
CC	Cloud computing
CRM	Customer relationship management
CVP	Customer value proposition
ELD	Equipment lifecycle data
ERP	Enterprise resource planning
IaaS	Infrastructure as a service
IB	Installed base
ICT	Information and communication technology
IoT	Internet of things
IT	Information technology
PaaS	Platform as a service
PDM	Product data management
PLM	Product lifecycle management
PO	Product-oriented
PSS	Product-service systems
R&D	Research and development
RO	Results-oriented
S4Fleet	Solutions for fleet management

SaaP	Software as a product
SaaS	Software as a service
SeS	Software enabled services
SLA	Service level agreement
UO	Use-oriented
XaaS	Everything as a service

# 1. INTRODUCTION

## 1.1. Background and motivation

Globalization demands fast changes and increases competition in all industries, making manufacturing context no exception. Due to the transition to a more knowledge-based economy, manufacturing firms have shifted to a more service-oriented business rather than stand-alone physical products (Gebauer, 2007). There are several benefits of servitization described in the literature, such as facilitating sales of the firm's products, lengthen relationships with customers, create growth opportunities in matured markets, balance the effects of economic cycles and respond better to demand (Brax, 2005). To actually realize those benefits, manufacturing firms are seeking for collaborations between their customers and other suppliers (e.g. software firms) to co-create value when delivering complex systems (i.e. combination of equipment, processes and software elements). By involving the customers as co-producers of value and quality, suppliers can better understand the customer's process and realize greater benefits for the customers and for themselves (Edvardsson & Olsson, 1996).

The transition of manufacturing firms to a service-oriented business requires a very thorough transformation that includes rethinking the business model of the firm. The concept of business model has been used widely in the academic and managerial world without having a common definition in all cases (Seddon et al., 2004; Mäkinen & Seppänen, 2007; Ovans, 2015). Nevertheless, it can be explained as the combination of two elements: value creation and value appropriation. The first one involves the various stakeholders and the key business processes, while the latter describe what is in for the company and the earning logic of these key business processes (Rajala et al., 2001).

In the manufacturing context, servitization transforms the industry from data-driven to a more cooperative knowledge-driven environment (Camarinha-Matos et al., 2009). This demands more flexible responses to changing business and the collection and analysis of lifecycle data from the equipment in the customers' use. The development of software-based services enabled by collecting and processing equipment lifecycle data (ELD) can add value and increase innovation of the service offering (Yang et al., 2009). In spite of the advantages of exploiting this possibility, the use of lifecycle data is challenged by various issues in inter-organizational cooperation, such as agility, security, privacy and interoperability aspects (Mezgár & Rauschecker, 2014).

Processing the lifecycle data requires specialized skills that manufacturing firms do not necessarily possess. When the activities needed to offer the right services are not part of

the core competences of the firm, it may require the cooperation of key partners (Osterwalder & Pigneur, 2010). Consequently, manufacturing firms can use their knowledge of the customers' needs to integrate other service suppliers into their processes (Finne & Holmström, 2013). The existence of collaborative relationships between different firms in business to business (B2B) environments has been studied and proved to create additional value for the end customer (Grönroos, 2004). Technology wise, there are plenty of studies related to the capabilities and challenges related to data collection, but it was found that the collaboration between supplier and customer has been the focus of most of them. Practical issues such as the tasks and position of each firm in the network have been overlooked, particularly the collaboration between manufacturing and software firms delivering services based on ELD.

This thesis explores the business model elements to deliver industrial software-based services, particularly focusing on those enabled by equipment lifecycle data. The phenomenon is studied by comparing the different points of view of manufacturing firms transitioning to service-oriented business and software service suppliers with experience in the analysis of product lifecycle data (PLM). Special emphasis is on studying the network roles and challenges presented when delivering complex systems. Particularly the conditions to enable data sharing and participation of the customer are relevant in this study, thus the thesis is focused on the managerial and strategic perspective of the value proposition.

The study used in this Master's thesis has been conducted as part of the Service Solutions for Fleet Management (S4Fleet) research program funded by the Finnish Technology and Innovation Agency Tekes, companies and research institutes, and coordinated by FIMECC (Finnish Metals and Engineering Competence Cluster).

## **1.2. Goals, research questions and scope**

The goal of this study is to discover a business model framework suitable for companies offering software-based services, which can particularly benefit firms delivering complex systems. In the context of this research, the complex systems refer to all the possible deliverables of manufacturing firms, such as equipment and processes, involving both service and software components. Particularly the use of equipment lifecycle data to enable industrial software-based services is considered. Hence, the main research question is...

*What kind of alternative business model can manufacturing companies use to provide software-based services using equipment lifecycle data?*

The new business model will be created by comparing the different suppliers' experiences and expectations. It is believed that the cooperation between the supplier of

complex systems and their prospective service suppliers can create an attractive value proposition while managing the possible risks and challenges. Therefore, the position and tasks to be performed by the two suppliers in the network is also of interest in this thesis. To complement the main research question the following sub-questions are raised...

- What are the tasks of each company (particularly manufacturing firms and software service suppliers) when using equipment lifecycle data for the delivery of industrial services?
- How can the industrial services based on equipment lifecycle data be enabled by the cooperation between companies?

The combination of equipment lifecycle data collection and software-based services provides a possibility to improve the service offering of manufacturing companies. This thesis explores the perspectives of both manufacturing firms and software firms in the context of industrial services offered for corporate customers. The focus is on industrial equipment, i.e., complex systems, and related industrial services. Consumer services are not covered, and also other parts of the supply chain are excluded. This study does not consider the customer's point of view as we did not have access to them directly. The long lifespan of the equipment is characteristic to the manufacturing firms: as the purchases of the manufacturing firm's equipment are scattered in time, the relation with their customers is almost transactional and in most cases dealt via distributors around the globe.

As a result of this thesis, a framework to deliver software-based services in complex systems is presented. Special attention is placed in the task division of manufacturing and software firms collaborating to deliver software-based services based on equipment lifecycle data. The conditions and challenges in the use of equipment lifecycle data for service delivery are presented too. The test and implementation of the proposed business model are left as topics for further research.

### **1.3. Structure of the thesis**

This thesis has been structured following the formats and regulations at Tampere University of Technology. It starts by setting the needs for this study and the research objectives. Then it presents a literature review that establishes the background information needed for the analysis of the empirical study while the gaps in previous studies are also identified. The third chapter illustrates the path followed to research the present topic. Next the results are presented in chapter four and analyzed in the discussion section. The last chapter presents the conclusions of this thesis. More detailed information is presented in Figure 1.

<b>Chapter 1. Introduction</b>
1.1 Background and motivation 1.2 Goals, research questions and scope 1.3 Structure of the thesis
<b>Chapter 2. Literature review</b>
2.1 Business models in industrial services 2.2 Software-based industrial services 2.3 Network definition for software-based industrial service delivery 2.4 Summary
<b>Chapter 3. Research method and material</b>
3.1 Research methodology and schedule 3.2 Data collection and analysis
<b>Chapter 4. Results</b>
4.1 Background: customers' expectations and concept clarification 4.2 Industrial service delivery network: firms' positions and tasks 4.3 Software-based services using equipment lifecycle data
<b>Chapter 5. Discussion</b>
5.1 Alternative business model for industrial software-based services 5.2 Conditions for industrial service promotion based on ELD 5.3 Synthesis
<b>Chapter 6. Conclusions</b>
6.1 Meeting the objectives 6.2 Limitations and implications for future research

**Figure 1.**      *Structure of the thesis.*

The literature review focuses on three main topics, which are keys for this study: business models in industrial services, software-based industrial services and industrial service delivery network. Each section is divided into more specific subtitles that describe the elements of business models, the servitization of manufacturing companies and the software-based services with the use of lifecycle data. The third chapter emphasizes the way empirical data was retrieved and how it was analyzed. The findings of the study are displayed in chapter four where the empirical data is content analyzed and divided in subtopics. Chapter five presents the discussion of the results while connecting them to the existing literature and pointing out the key findings and contribution of this study. Chapter six poses the conclusion and is the ending part of the thesis.

## 2. LITERATURE REVIEW

There are two key topics of interest for the development of this thesis: business models and industrial services. These concepts were studied and analyzed as presented in the following sections, which allowed the identification of other relevant concepts and issues. The definition of business model and its elements is the starting point of the literature review, followed by the explanation of business models in the context of complex systems. The services section focuses on explaining industrial services, software-based services and the role of equipment lifecycle data in that setting.

### 2.1. Business models in industrial services

In order to discuss alternative business models for software-based services some basic concepts need to be defined, and to do so, this section includes three subtitles. The first one will define what a business model is, limiting the literature to the four definitions that were found more relevant for the scope of this thesis. The second subtitle identifies the most relevant elements of a business model to understand what it needs to be looked at when developing or identifying business models for software-based services. Lastly, business models studied in the context of complex systems are studied.

#### 2.1.1. Definition

The idea of *business model* (BM) has been wrongly confused with corporate strategy or business case, mainly because of three reasons. Firstly, the term is relatively new and it has appeared in several journals, although it has not always been defined. Secondly, there are several disciplines interested in it such as: eBusiness and eCommerce, information systems, strategy, business management, economics and technology. Lastly, new technological ventures are interested on business models to define their products and services. (Al-Debei & Avison, 2010)

Business model as a concept has been mentioned in literature since the late 90s, but it has been commonly used as a buzzword (Seddon et al., 2004; Mäkinen & Seppänen, 2007; Ovans, 2015). There are several definitions encountered in management literature from diverse authors, perhaps because the topic has developed interest from many disciplines (Shafer et al., 2005). Nevertheless, it is important to note that a business model is different to a business idea (Rajala et al., 2001). The main difference between the business idea and model is that the business idea should answer, at least partially, the questions of “What?”, “To whom?”, and “How?”. The first question refers to the kind of product or service is offered, the second question identifies the target market



and the third one should explain the structure of the operations in order to sell that product or service. (Rajala et al., 2001)

In early studies, Timmers (1998) presented one of the first and most used concepts for BM when presenting his work related to electronic markets. His definition not only contemplates the option of a product as the offering but as well the services and information flows involved in a firm's offering. Rajala et al. (2001) summarized the idea of business model particularly focusing his study on the software industry as a combination of two elements: value creation and value appropriation.

Later when different disciplines became more interested in the term, more concepts emerged outside the original sphere of electronic markets and software industry. Afuah (2004) considered his definition from a strategic management point of view, as business models are related to making money and strategy to performance. Differently for Teece (2010), the business model provided data and other evidence demonstrating how a business creates and delivers value to its customers. Interestingly, in Teece's work the business model is considered as a conceptual model rather than a financial one, due to the amount of assumptions done when establishing it for the business. A summary of the relevant concepts and their context of study for business models are presented in Table 1.

**Table 1.** *Business model definitions and context of study.*

<b>Authors(s)</b>	<b>Context</b>	<b>Definition</b>
Timmers (1998)	Electronic markets	An architecture for products, services and information flows, including a description of various business actors and their roles; a description of the potential benefits for the various business actors; and a description of sources of revenues.
Rajala et al. (2001)	Software business	The ways of creating value for customers and the way in which a business turns market opportunities into profit through sets of actors, activities, and collaborations.
Afuah (2004)	Strategic management	Set of activities which a firm performs, how it performs them, and when it performs them to earn profit.

Authors(s)	Context	Definition
Teece (2010)	Business strategy, innovation management, and economic theory	A business model articulates the logic and provides data and other evidence that demonstrates how a business creates and delivers value to customers. It also outlines the architecture of revenues, costs, and profits associated with the business enterprise delivering that value.

As mentioned earlier, the definition of BM is not yet unanimous, but what most authors agree on is that a business model is meant to tell how a company will make money while offering something its customers' value. In other words, the business model should identify what is the tradeoff between the obtained benefits and price to pay from the buyer's point of view, but also what are the necessary elements for the firm to obtain a profit out of it. These elements are described in more detail in the following section, considering different author's points of view.

### 2.1.2. Business model's elements

Similarly to the definition of business models, different authors identify distinct elements relevant to their study context. The main focus of the authors is to identify which elements can create something interesting or useful for the customers, while also identifying what is needed to obtain something in return, understood as *customer value*. This concept has been discussed and defined by several people too. For example, Zeithaml (1988) considered value was the assessment of the utility of a product based on the perception of what is received versus what is given. Likewise, Monroe (1990) defined customer value as the buyers' tradeoff between quality and benefits received, relative to the sacrifice they perceive by paying the price. Later, Gale (1994) defined it as the market perceived quality adjusted for the relative price of the product. What all definitions have in common is the contrast between the benefits obtained and the price they have to pay.

At first glance, Rajala et al. (2001) business model definition already defines a couple of elements: value creation and value appropriation. The value creation refers basically to what other authors identify as the customer value, taking into account the different elements involved such as business processes and stakeholders. On the other hand, value appropriation is nothing more than the earning logic, defining how the company will create profit. (Rajala et al., 2001) The details of these two elements were divided in four as shown in Figure 2.



**Figure 2.** *Business model elements, adapted from Rajala et al. (2001).*

The product development approach considered how the process would create the *customer value proposition* (CVP) and how it would be structured. Secondly, the revenue logic considers how the sales value of the product or service offering is captured. Thirdly, the marketing and sales approach includes the marketing and distribution strategy and how the distribution channels are created, which also takes into account the sales and implementation cycle of the final offering. Finally, the servicing and implementation approach considered all the pre-sales and after sales services while considering how it is delivered or implemented. (Rajala et al., 2001)

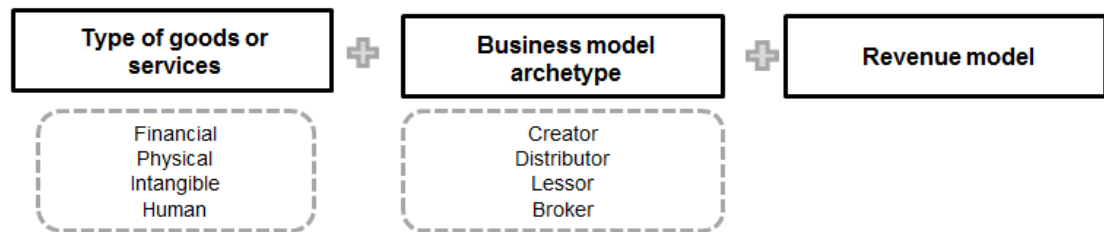
Johnson et al. (2008) used the components of the business model to define the concept itself when studying ‘business model innovation’. Similarly, Afuah (2004) considered the activities, resources and costs plus the position of the company and the industry factors. The four components of the business model, according to Johnson et al. (2008) and Afuah (2004) are shown in Figure 3.



**Figure 3.** *Business model elements, adapted from Johnson et al. (2008) and Afuah (2011).*

First, the CVP takes into account the target customers, what is the offering that better satisfies the customer’s needs and the steps that should be followed to accomplish the fulfillment of needs. Secondly, the profit formula takes into account the revenue model or earning logic, the cost structure, margin model and resource velocity (how quickly the resources need to be used to support target volume). The third element, key resources, refers to all the people, technology, products, facilities, equipment, channels, and brands to deliver the CVP to the targeted customer. Lastly, the key processes involved in a business model are those that help the CVP to be repeatable and scalable and might involve besides de processes definitions the roles, metrics and norms to be followed. (Johnson et al., 2008; Afuah, 2011)

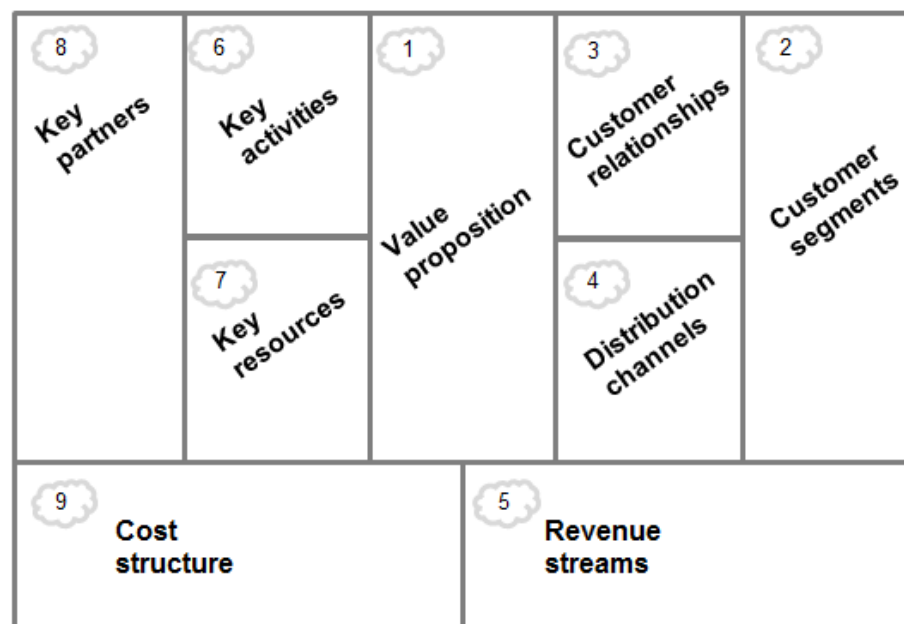
A simplified approach was presented by Popp (2011) when studying business models in the software industry. Only three elements were mentioned: the type of goods or services, the business model archetype and the revenue model. These characteristics or elements of a business model are presented in Figure 4.



**Figure 4.** *Business model elements, adapted from Popp (2011).*

What Popp (2011) expressed as the “type of goods or services” is similar to what other authors (Rajala et al., 2001; Johnson et al., 2008; Osterwalder & Pigneur, 2010) call the value proposition. These goods or services can be classified in financial goods such as cash and other assets, physical goods, intangible goods like software and intellectual property, and human services. The archetypes refer to the patterns of doing business and Popp classifies them in four: the first archetype, the creator, is the one that transforms supplied goods and assents into a product; a distributor buys already made products and provides them to customers; a lessor will allow the use but not the ownership of the final product or service and finally; a broker facilitates the matching of buyers and sellers without owning the product or service. Lastly, the revenue model defines the type of compensation a company gets for its goods and services, similar to the revenue logic and profit formula presented by other authors. (Popp, 2011)

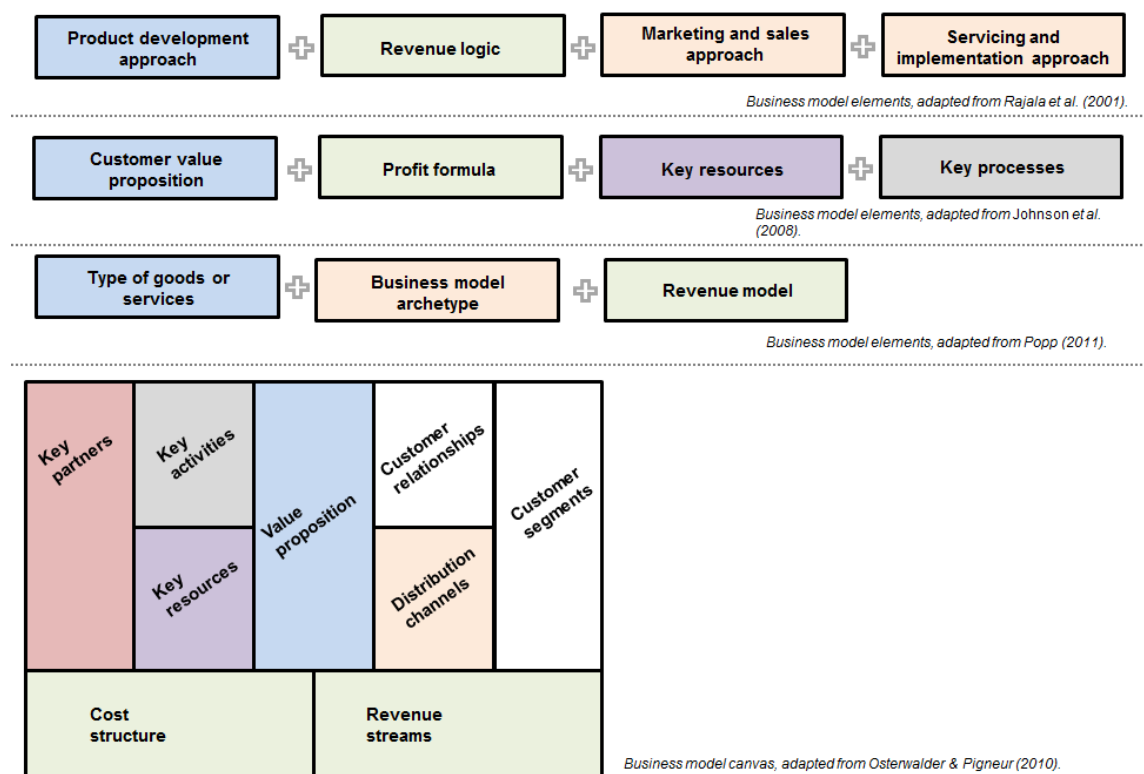
The previous approaches are rather simple, even when considering external issues such as the industry environment. Osterwalder & Pigneur (2010) presented a more detailed approach in the form of a canvas. This idea contemplates nine elements that should be defined in order to create or update a business model (Osterwalder & Pigneur, 2010). The business model canvas is presented in Figure 5.



**Figure 5.** *Business model canvas, adapted from Osterwalder & Pigneur (2010).*

The value proposition element is in the center of the canvas and the rest of the elements describe the needed resources and channels to deliver the value to the selected customers. The customer segments answer to the business idea question of “who will the value proposition serve?” and the customer relationships should describe how the link between the firm and its customers will be maintained. The distribution channels define how to deliver the value propositions to the customers, through communication, distribution and sales channels. The revenue streams are considered the result from the value propositions successfully offered to the customers. The key resources and activities are related, and the resources describe the assets needed to deliver the previously described elements and the activities refer on how the resources are used. Key partnerships are mentioned because some activities are not part of the core competences of a firm, so some resources and activities are acquired from outside the enterprise. Lastly, the cost structure is the result of the elements of the business model and should reflect the most important costs incurred during the operation of the business model. (Osterwalder & Pigneur, 2010)

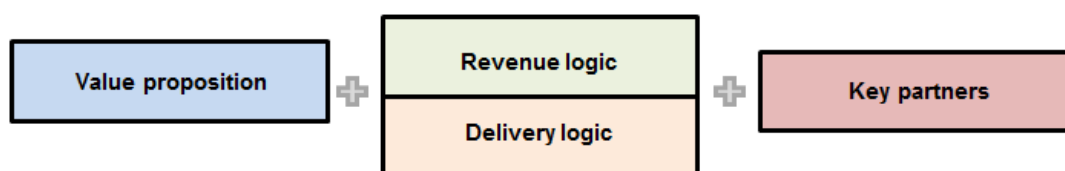
As part of the conceptualization of the elements of business models, the presented descriptions show how there is no universal idea in literature. Nevertheless it is possible to identify elements that are shared along the different authors. Figure 6 identifies similitudes and differences from the elements presented before.



**Figure 6.** Compilation of business model elements.

With the figure above is seen that there are three elements present in all elements' definition, although some times with a different name: customer value proposition, distribution model and the revenue model. All authors share the idea the CVP is a core element of a business model as it defines the product or service to be offered. The revenue model presented in all cases emphasizes the way in which the firm will profit out of the defined product or service. The difference is that Rajala et al. (2001) focuses on defining the ways to sell, to market and implement the offer while Johnson et al. (2008) bundles these two elements as "key processes" and defines as a different element the resources involved in the value creation. Differently, Osterwalder & Pigneur (2010) break down the business model idea into more elements to identify the sources of revenue, costs, resources and stakeholders involved in an efficient business model creation sharing.

The concept of key partners and customer relationships has lacked attention in the context of defining business models. Even though it is present in the Osterwalder & Pigneur (2010) canvas, other authors have not considered them. For the purposes of this thesis, this particular element is an important issue, as the partnership between manufacturing and software firms and their roles are studied as part of the software-based service offering. To better serve the scope of this thesis, a selection of the predominant elements in the literature and the concept of key partnerships are considered. These business model elements are presented in Figure 7.



**Figure 7.** *Business model elements in this study.*

The means by which the value will be acquired are part of the BM's elements as the revenue logic while how the offering will be distributed and the resources needed are represented as the delivery logic. The key partners play a key role as they represent the collaboration, both inside and outside of the firm. Identifying and defining each one of the elements will help to find alternative business models that can be applied when manufacturing and software firms collaborate to supply software-based services.

### **2.1.3. Business models for complex systems**

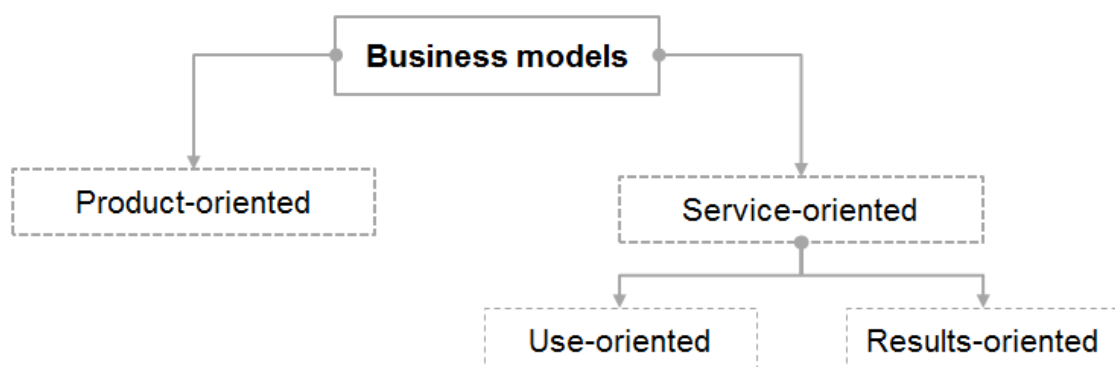
Once the definition and elements of business models have been clarified, it is relevant to explain how they are classified in the literature and what triggers the innovation on business models. In order to maintain competitive advantage, companies need to innovate on their business models instead on focusing only on the development of new technologies. This implies that firms need to change the way they offer their goods to

the customers. The change and innovation in the business model may define the success of a firm, as it responds to transitions of internal and external resources. (Chesbrough, 2010)

As described in the previous section, the key element of a business model is the value proposition. According to Maglio & Spohrer (2013), the innovation of a business model can be also understood as the design of the value proposition, while considering different stakeholders perspectives. Demil & Lecocq (2010) explain how a business model can have two different uses, one can be a static blueprint of the steps to generate value for the customers and as a consequence, to the organization. The second use of a BM explained by them is that it helps the transition on the organization towards obtaining the aforementioned mentioned value. In a way, the business model is the way an organization can assure sustainability by reacting to changes and following a plan to create and acquire value.

This shift towards business model innovation highly relies on how people are connected all over the world, the access rights they have to their own and others' information. Hence, the world is shifting towards a less "goods-dominant" economy, increasing the services importance when defining the value proposition (Gebauer et al., 2005; Mont, 2002). This shift has led to a new focus on product-service systems (PSS), which Mont (2002) summarized as being "a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models". The focus on PSS business models is relevant for this thesis as it includes the delivery of software-based services on complex systems.

A classification of three types of PSS business models has been explained by Tukker (2004), depending on the type of value proposition, whether it is product or service oriented. Tukker's classification of PSS business models was used by Kley et al. (2011) when studying new business models with a focus on electric cars and is presented in Figure 8.



**Figure 8.** PSS business models, adapted from Tukker (2004).

The first type or category is the traditional product-oriented (PO) business model, although services can still play a role as support to the core product. The services can help to engage customers and increase sales. The second category, referred to as service-oriented business models, is subdivided in two subcategories: use-oriented and result-oriented business models. The use-oriented (UO) business model deals with a provider that makes the physical product available through leasing or renting agreements. Lastly, the result-oriented (RO) business model does not focus on the delivery of a core product, but instead provides to the customer a result or particular outcome. (Tukker, 2004)

Reim et al. (2014) pointed out that the interest in literature related to companies offering product-service and service-product solutions is increasing, abandoning traditional business models' focus and turning to their study in the context of more complex systems. Nevertheless, studies related to business models applied to software-based industrial services are still scarce. The traditional approach of studying the topic from individual industrial perspectives is becoming challenging due to the growing collaboration between firms and the partnerships formed between those. To better understand the characteristics of business models for software-based services in complex systems, their definition and evolution is presented in the following section.

## **2.2. Software-based industrial services**

This section starts by stating the definition of software-based services and is followed by study of the transition of manufacturing and software firms towards servitization. Then, the current trends in the ICT industry are presented to set a background for the analysis of software-based service delivery based on equipment lifecycle data, which is the last part of this section.

### **2.2.1. Background**

The concept of products is widely understood even beyond the business arena, considering them as tangible elements that fulfill a certain need or demand (Brax, 2005). The definition of services has been somehow more complicated due to its intangible nature. There are several labels under which the concept of services can be tagged for the purposes of this thesis, some of them found in the literature are: industrial services, service strategy, product-related services, and after-sales services (Oliva & Kallenberg, 2003).

Lovelock et al. (1996) defined a service as “an act or performance offered by one party to another. Although the process may be tied to a physical product, the performance is essentially intangible and does not normally result in ownership of any of the factors of production”. This definition has been widely spread and accepted in the literature, making it also the pillar in the understanding of services for this study.



The concept of *software-based services* is not found in the literature exactly as such, leaving it often open for interpretation. For example, Bennet et al. (2000) talked about the “service-based model of software”, where services are setup to fit the requirements in a certain point in time. Some years later, Black (2008) described a similar term: “software-enabled services” (SeS) while he also compared it with “software as a service” (SaaS). Table 2 shows the characteristics of concepts that have used as software-based services.

**Table 2.** *Approaches to “software-based services” (adapted from Black 2008 & Bennet et al. 2000).*

	<b>Service-based model of software</b>	<b>Software as a service (SaaS)</b>	<b>Software-enabled services (SeS)</b>
<b>Use</b>	External: customers	External: customers	Internal functions: employees. External: customers' services.
<b>Business' base</b>	Software	Software	Service
<b>Software management</b>	External: Service provider/manager	Internal: run on behalf of the customer.	Internal: company operates it for its own benefit or pays someone to operate it.
<b>Tolerance to flaws</b>	Bounded to service level agreements (SLA)	High: if software breaks, the business goes on.	Low: is software breaks, the business stops.

As it can be seen from the table above, these definitions have similarities and it is no surprise that the terms are mixed or even confused sometimes. The early introduction of Bennet et al. (2000) of the service-based model of software established a precedent to how the software industry was shifting. In his post, Black (2008) mentioned that SaaS has been used in many contexts and is a very popular concept as it defines the delivery and revenue models where the software itself is still the main benefit the customer gets. On the other hand, with SeS, the business is conducted with the help of the software, although it is not considered as the core offering (Black, 2008).

Simply put, the customer value offered by SaaS relies on the software itself, whereas the customer value from SeS are the consequent services from the use of the software. From a manufacturing firm's perspective, the software that is provided as part of the physical equipment is the core of the SeS. The software tools to support the use of the equipment can also be considered as part of it, such as systems to do the configurations or to monitor the status of the installed base. In the context of this study, software-based

services are the result of using software tools as enablers, particularly for processing and storing lifecycle data from the customer's equipment.

When considering only the software element of the software-based industrial services, it is inevitable to note the changes in the industry. Software firms have supported several changes in their business models to adapt to the needs of their markets. Their software solutions often involve intangible and human services as well as the software itself, forcing them to have hybrid business models. The emphasis in this business model hybrid has been on software offered as a service enabler, while complementary solutions are offered around it.

By studying SaaS' business model evolution, a background for the study of business models for software-based services is presented. An analysis of previous studies related to SaaS business models is shown in Table 3, where the key findings and remaining gaps are highlighted.

**Table 3.** *Analysis of previous studies related to SaaS business models.*

<b>Research Study</b>	<b>Primary focus &amp; methodology</b>	<b>Key findings</b>	<b>Remaining gaps</b>
Turner et al. (2003)	Turning Software into a Service. Review	SaaS model bundles several different services. Overcomes limitations of traditional SaaP model.	Empirical study, B2B specifications.
Sääksjärvi, Lassila & Nordström (2005)	SaaS model compared to ASP. Review	Customer's benefits constrained by supplier's capabilities. SaaS provider plays a role as active agent in a supplier network instead of standalone agent.	Empirical study, B2B specifications. SaaS provider value/benefits.
Laplante et al. (2008)	What's in a Name? Distinguishing between SaaS and SOA. Technical review	In SaaS software is delivered as utility service. Differentiation with SOA (previous technology).	SaaS delivery details and customer value.

Research Study	Primary focus & methodology	Key findings	Remaining gaps
Campbell-Kelly & Garcia-Swartz (2009)	The software industry in the internet era. Review	Subscription basis as popular revenue model. Transition of the industry from mass-market to enterprise software.	Clear business model for software services. B2B application.
Weindhart et al. (2009)	Cloud computing and differences with Grid computing. Review	Cloud Business Model Framework (infrastructure, platforms and applications layers). Pay per use and subscription as most popular pricing models.	Business models, pricing of complex services, safety of critical data. B2B application.
Popp (2011)	Software industry business models. Review and industry examples.	Business models for SaaP and SaaS (emerging). Successful BM and BM archetypes.	Revenue models for emerging software services. B2B application.

As illustrated by the table above, SaaS has been studied already for more than a decade from the perspective of technical and management/business studies. What can be seen from previous studies is that the customer's benefits are easy to spot when implementing SaaS. Waters (2005) considered these benefits to be 1) reduced total cost of ownership 2) increased speed of implementation 3) reliability as the vendor takes care of the software at all times 4) regular updates without the need to install new software and 5) risk mitigation. These benefits have been considered only from the consumers' perspective as found in the previous studies, leaving the research possibility of the B2B context open.

Despite the increasing benefits for the customers, there is a gap in the literature related to identifying the challenges and the benefits of the providers. This issue has been already mentioned in the study of Sääksjärvi, Lassila & Nordström (2005), but it was not encountered in the following literature. Similarly in the manufacturing context, the benefits for the suppliers when delivering services have been overlooked and the focus has been on the customer's benefits.

Additionally, most of the revenue models of SaaS seem to be more a practical issue and review articles do not go too deep into it, although most common practices seem to be pay-per-use and subscription (Weinhardt et al., 2009; Laplante et al., 2008). The delivery models in SaaS, according to Turner et al. (2003), “focuses on separating the possession and ownership of the software from its use”. This might be the reason why the delivery models show a trend towards wireless methods rather than on premise infrastructure, considering Cloud Computing services and the possibilities that Internet has enabled (Weinhardt et al., 2009). Moreover, the Internet and wireless technologies have enabled many kinds of on-demand and transaction-based pricing models, shifting the software industry’s emphasis to services rather than physical products (Cusumano, 2008). This shift is again similar to the undergoing transition in manufacturing industry.

The main difference between the diverse business models in the software industry are related to the way the software is delivered and the different payment methods. While studying delivery and revenue models for software-based services, the concept of Cloud Computing (CC) often appears in the literature, including the research related to manufacturing industries. The cloud represents an option to access and deliver computing, software and storage of data over a network, often the Internet (Mint Jutras, 2012). The identified layers or types of CC in the literature are normally three, i.e. Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). These three concepts define the composition of cloud computing or everything as a Service (XaaS). (Xun Xu, 2012)

The delivery models of software services can now be remote and web-based or bundled as hardware products, in this way, firms can target from early adopters to other industries (Cusumano, 2008). Financially, CC provides the user the option of pay-per-use, creating an advantage for an average user (Mezgár & Rauschecker, 2014). Although it has been used interchangeably, Mint Jutras (2012) mentions there is a difference between SaaS and CC, because all SaaS is CC but not all CC is SaaS. This difference arises because in CC the software may be installed on the user’s computers and the data or services are accessed remotely while with SaaS nothing is installed on the customer’s side (Mint Jutras, 2012).

The transition manufacturing firms are undergoing while delivering complex systems is similar to the evolution from software products to SaaS that software firms experienced. Now a background has been set and the shift from product to service orientation and the delivery of complex systems in the manufacturing context can be analyzed in the following section.

### **2.2.2. Manufacturing shift from product to service orientation**

As the competition intensifies in the manufacturing industry, companies tend to rely more and more in the service business (Gebauer et al., 2005). Sometimes, products are

sold at low price or even at cost level and the revenue is compensated by their service offerings (Kucza & Gebauer, 2011). Under this situation, firms can probably survive with a healthy hybrid business model, where product sales continue to grow but services grow faster (Cusumano, 2008). The transition between products to service orientation from manufacturing companies requires a stronger relation or partnership, rather than driving business by single transactions (Oliva & Kallenberg, 2003).

Often customer service and product services can be bundled with the tangible product to increase the value of the core offering of a firm, differentiating this way from the market competition (Brax, 2005). Malleret (2006) identified four main benefits of developing services in manufacturing companies, them being:

- Building customer loyalty
- Differentiation
- Increasing and stabilizing turnover
- Corporate image

Malleret (2006) considered that a way to build the customer loyalty is when companies propose additional services to their customers, in this way the grounds on which the supplier-customer are built change from a transaction-based into a long-term relation as the parties need to keep in touch. The differentiation referred to how the offerings are more difficult to compare against those of the competitors when products and services are combined in different ways. This results on lower price competition, which improves the firm's profitability. Also, increasing and stabilizing turnover is the result of a firm offering services along with the products, increasing their participation in the value chain. Services, in contrast with products, are not only sold once but follow a recurring pattern, generating regular cash flows. Lastly, companies offering services build a stronger corporate image because certain services can show the firm's involvement in technological advances, product quality and others. (Malleret, 2006)

On the other hand, customers of manufacturing firms are nowadays outsourcing responsibilities to ensure their products function properly (Gebauer, 2007). Manufacturing companies can categorized their service approaches into customer service, product services and services as products. Customer services take care of customer relationship and loyalty in a general level. Product services support product operation and facilitate the sale of the products sold by the firm. Services as products are independent offerings and are not constrained to be purchased with other transactions. (Mathieu, 2001)

Oliva & Kallenberg (2003) defined four different classifications of services that can be offered to a product's installed base, according to the orientation of the services (product or end-user's process) and the level of commitment (transaction or relationship-based). A product's installed base (IB) is the total amount of products currently used, and the range of services related to them that can be positioned through



infrastructure securely integrated into the Internet, connecting physical products with the virtual world (Mazhelis et al., 2013).

With the increasing possibilities enabled by remote monitoring systems, such as RFID and machine-to-machine communication, the IoT presents a chance to introduce new business opportunities enabled by the collected data of the different connected devices. The collected data communicated through the IoT needs to represent a win-win situation for all stakeholders. To develop new business models based on data, a value-focused approach should be taken into account rather than a cost approach (Mazhelis et al., 2013), especially in B2B relations. The following section presents the service possibilities and business development opportunities based on the collection of equipment lifecycle data.

### **2.2.3. Equipment lifecycle data**

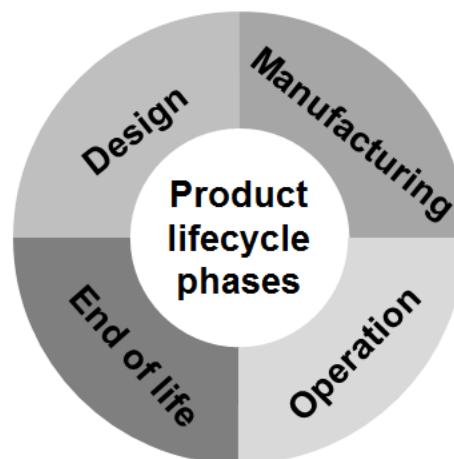
With the increasing relevance of data sharing and opportunities enabled by ICT, firms collaborate with their customers to co-create value (Edvardsson & Olsson, 1996) and knowing the basics of each other's business is key for its success (Sandin, 2015). Bennet et al. (2000) made the annotation that services are composed by other smaller services that are procured and paid when needed, involving the human factor to manage the relations between consumers and suppliers. This conception takes software-based services far from a mechanized process and shows the importance of human interaction to provide them.

Services based on products are limited to the lifecycle of the physical product (Oliva & Kallenberg, 2003), but if the data collected from the lifecycle is analyzed and transformed into valuable information related to the processes of the customer, there is a new range of service possibilities (Yang et al., 2009). For example, handling inventory and managing spare parts are only a few examples of the processes manufacturing firms can take over the customer's processes (Mezgár & Rauschecker, 2014). Other possibilities related to the information collected from the customer's equipment are supported by software-based services.

More specifically, *equipment lifecycle data* (ELD) refers to the data that can be collected through all the lifecycle phases of an intelligent product, from the market requirements to the disposal or decommissioning (Qureshi et al., 2014). Previous literature discusses the concept of "product lifecycle data", but the word equipment has been selected to emphasize the industrial context in this particular study, and to create a clear distinction from the business-to-consumer market. Modern technologies based on ICT have enabled automatic data collection from the lifecycle in intelligent products. This is why particularly when companies collaborate with suppliers or partners, data management practices increase their relevance (Kropsu-Vehkaperä et al., 2009)

Studied from the design perspective in the engineering industry, Qureshi et al. (2014) encountered that most authors divide the product lifecycle between four and nine phases. Their approach concluded with five phases, starting by establishing the need or identifying the problem to be solved. The second phase is design, where the conceptual solution is developed. Subsequently, the third phase is implementing the concept by manufacturing, installing, testing and launching the final product. The use or support stage comes next, where the finished product is operated and monitored, some maintenance may also take place in this stage. Lastly, the end of life stage refers to the recycling, disposal and update of the product. (Qureshi et al., 2014)

Brunssman et al. (2011) presented a more traditional view with only three phases in the lifecycle of industrial equipment: design, manufacturing, and service or operational phases. When comparing this almost simplistic approach with the phases presented by Qureshi et al. (2014), it is possible to spot common ideas and present the four product lifecycle phases that better serve the purposes of this study. They are presented below in Figure 10.



**Figure 10.** *Product lifecycle phases in this study.*

The design stage involves the need identification and design, while manufacturing stage refers to the implementation and service or operation phase involves the use of the end product. The end of lifecycle is presented as a separate stage as its relevance has risen in last years, due to sustainability awareness in different industries. During each one of these stages there is some data generated but it is not always stored or processed. The first two stages create data that is often captured but once it is delivered to the customer, the integration stops due to the amount of involved stakeholders (Brunsmann et al., 2011).

The literature has already addressed the technical capabilities and challenges of data collection of remote monitoring systems. Westergren and Holmström (2012) presented applications of sensor-based solutions in a real industrial case and mentioned different value drivers for the stakeholders in a network. Their study focuses on the open



innovation paradigm and establishes the importance of ICT (Information and Communication Technology) and trust to overcome security issues. It does not focus on the positions and tasks of each player of the network nor provide more details about how to utilize the collected remote data. Technical literature regarding the resources needed to ensure data security and privacy is also available as in Mezgár & Rauschecker (2014), but it has not been broadly studied from a business perspective. Similarly in the technical stand point, Vezzetti (2009) presented Web3D software tools to visualize lifecycle data as part of a Product Lifecycle Management initiative. These software tools can benefit network partners with integration and interoperability issues but details about the tasks and business opportunities for industrial suppliers are not explained. Based on these studies and other recent empirical research, it was found that the collaboration between manufacturers and software providers to offer new industrial services has not been studied as much as the more traditional cooperation between supplier and customer in value co-creation. Lastly, despite the increasing possibilities enabled by remote monitoring systems and the Internet, data collection from the supplier's point of view often ends once the equipment leaves the factory and is delivered to the end customer.

According to Yang et al. (2009), the intelligent product's data can be classified into static and dynamic, depending on the stage of the lifecycle it is collected. The static data is related to the specifications of the product and is collected from the first stages of its lifecycle. These data can include the specifications of the product such as the materials, components, suppliers and how it operates, and it is often studied under the concept of product data management (PDM). On the other hand, the dynamic data is created during the operational phase of the product and is studied as product lifecycle management (PLM). (Yang et al., 2009; Kropsu-Vehkaperä et al., 2009)

Previous research has frequently looked into the customer's (i.e. equipment users) viewpoint regarding how equipment lifecycle data is used, and the benefits for the manufacturer are often overlooked. Generally, identifying bottlenecks in the operations as well as analyzing possible break downs to minimize negative cost impact are mentioned as benefits for the customers (Brunssman et al., 2011). Most of the benefits of the equipment lifecycle data are connected to the customer's satisfaction and supporting them by taking over some of their operations. Manufacturing firms as suppliers could also benefit from the equipment lifecycle data by forecasting better spare parts stock needed to fulfill customer's demand and decrease warehouse costs. R&D processes can be also improved by knowing exactly how the equipment is being used (Kucza & Gebauer, 2011; Yang et al., 2009). It is necessary for the manufacturers to offer attractive industrial services to get access to the data in the first place.

#### **2.2.4. Software-based services built on equipment lifecycle data**

The manufacturing firms' interest is to utilize the equipment data to identify service opportunities, and develop and deliver appropriate industrial services in line with the customers' needs (Edvardsson & Olsson, 1996). The previous literature makes evident that just collecting the data is not sufficient to offer more services, but it is necessary to analyze and store it too. Unfortunately the collection of equipment data is not easy in practice and the challenges related to ownership, maintenance and relevant processes have not been widely studied as the academic research areas of PDM and PLM are relatively new (Kropsu-Vehkaperä et al., 2009).

Manufacturing firms utilize different kinds of software tools to handle internal information such as ERP systems (Enterprise Resource Planning), CRM systems (Customer Relationship Management) and supply chain management information systems. These systems can facilitate tasks related to resource optimization, marketing and supply chain management, but there are processes linked to R&D, product provision and support services that are not solved with them (Yang et al., 2007). Product Lifecycle Management systems have emerged as a solution to manage the equipment lifecycle data generated during the distribution, use, maintenance and end-of-life stages.

The term PLM is found in literature, often confused with an IT tool, although it is a wider concept rather than an IT system (Qureshi et al., 2014). As an IT tool, PLM can be very important to process and manage the lifecycle data. Yang et al. (2007) presented a PLM model where the dynamic data is processed to enable industrial services. The data flow starts when the intelligent equipment transmits dynamic data generated during customer's operations and maintenance through a communication's support infrastructure like the internet. Once the data arrive to the PLM system on the manufacturer's side, it has to be stored and manipulated so that it is transformed into information and knowledge that can later on enable industrial services that can benefit the stakeholders involved. (Yang et al., 2007)

Despite the idea of PLM has raised interest lately, deeper studies based on software-based services utilizing data are still missing. Moreover, the studies of the topic focusing on complex systems or fleet level management are even narrower. Issues such as ownership of the PLM systems and the data created, and data security have been overlooked from the business perspective. Table 4 presents some of the articles found related to the matter and the remaining gaps numbered as follows: a) Analysis in complex systems context, b) Software use in product lifecycle management and c) Use of lifecycle data for service offering.

**Table 4.** *Analysis of previous studies related to the use of lifecycle data.*

Research Study	Context/ Primary focus	Methodology	Key findings	Remaining gaps		
				a)	b)	c)
<b>Yang et al. (2009)</b>	Lifecycle data acquisition to enable services.	Literature review and empirical test cases.	How a service enabler (software agent) receiving lifecycle data can enable services by providing information and knowledge.	X		
<b>Brunsmann et al. (2011)</b>	Product lifecycle phases and their data management and integration.	Literature review	Challenges of integration of lifecycle data and benefits that can be exploited further.	X	X	
<b>Jun et al. (2009)</b>	Use of RFID in PLM.	Literature review	Sensor's application in the different stages of the lifecycle.	X	X	
<b>Jiao et al. (2013)</b>	Lifecycle unification in complex environments with cloud computing.	Empirical study.	Benefits of cloud computing for complex projects' lifecycle data management.			X
<b>Hall et al. (2006).</b>	Project and information management over fleets.	Empirical study.	Benefit of sharing project's information and solutions to integrate product lifecycle data to minimize costs and risks in fleet level.		X	X

These studies have not yet addressed all together the use of software to manage lifecycle data in complex systems and the services enabling with the processed data. Hall et al. (2006) studied the complexity of systems in project based industry mainly, and how the

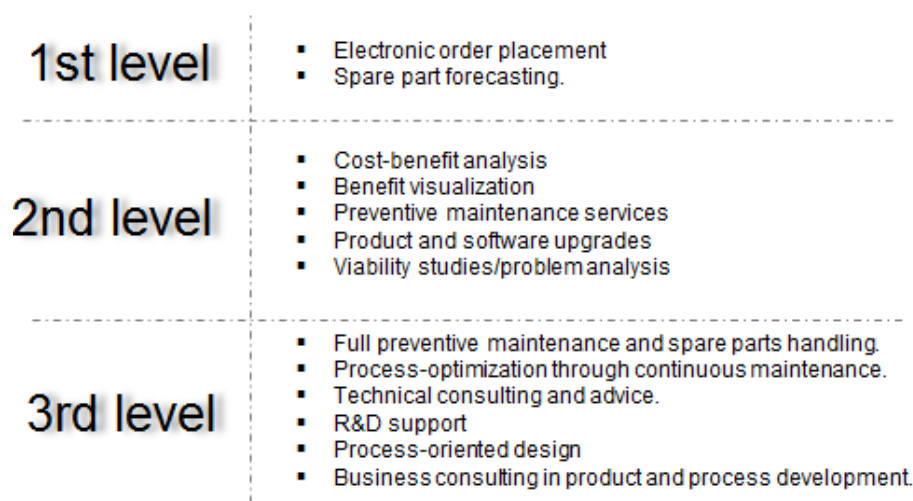
integration of information can provide several benefits and control to the involved stakeholders. On the other hand, the construction and architecture industry involve complex systems as different service providers are integrated in the same solution, therefore Jiao et al. (2013) exploited this complexity to study how the trending cloud solutions can help sharing information amongst the involved parties. Nevertheless, these two studies do not show how can the data benefit a manufacturing firm by enabling services with the processed data, nor explain how SaaS can deliver customer value when applied to the collected data.

When focused only on how the lifecycle data can provide useful information to deliver services, Yang et al. (2009) study presents a very interesting insight. Product lifecycle data can be a valuable service enabler, but “intelligent products” can’t go further the data collection or extraction (Yang et al., 2009). To actually be able to deliver different kinds of services, the collected data must be transformed into information and software-based services can enable this. Yang et al. (2009) presented the following types of services that can be created based on product lifecycle:

- Remote diagnosis and monitoring
- Rental and sharing
- Analysis of use patterns
- End-of-life treatment
- Better service

Manufacturing firms can provide remote management of spare parts, preventive maintenance, as well as offering modernization services by the end of life of the products. Similarly, internal processes – based on dynamic data related to equipment usage and distribution – are possible, such as remote diagnosis and monitoring. Deeper knowledge about use patterns can give the supplier a better understanding of the customers’ needs to develop the equipment (Yang et al., 2009).

By relying on external software tools, Kucza and Gebauer (2011) proposed a classification of services in different sorts of operations based on the level of knowledge intensity gained through the data collection. Those operations can be divided in four: customer service, basic services for the installed based, maintenance services and R&D oriented services (Kucza & Gebauer, 2011). This classification is shown in Figure 11.



**Figure 11.** *Software-based services according to knowledge intensity, adapted from Kucza & Gebauer (2011).*

In the first level, customer services are addressed by providing basic software-based services that include electronic communication. In the second level of knowledge intensity the services are more oriented to provide extra value for the installed base and also some general customer services. The higher level of knowledge intensity deals with all the kinds of service operations, including maintenance and R&D oriented services. This level of intensity implies a stronger relation between the manufacturer and the end customer. (Kucza & Gebauer, 2011)

Despite the diversity of services enabled by processed lifecycle data, the focus is on single products, not on a full installed base or complex systems deliveries. There is still space for studying what are the possibilities when studying lifecycle data from a complete installed base. The context in which software-based services built on lifecycle data in complex systems has not yet been studied and exploited. The way these can add value and be presented in a business model is still missing in the literature as the industrial focus has been mainly related to preventive maintenance and reactive actions.

The software systems used in industrial service delivery –such as PLM systems– require not only the technical competences, but also an understanding of what data can be generated and how it can be enriched. By sharing knowledge, resources and experiences, firms in a collaborative network could complement their core capabilities (Camarinha-Matos et al., 2009) and fulfill the technical competences and the potential of the generated data. The following section explains the roles that each stakeholder has when handling the data generated by the equipment in a B2B context.

### **2.3. Network definition for software-based industrial service delivery**

Information and communication technologies may drive changes in the stakeholder configurations of industrial service delivery. Previous studies have focused on the dyadic cooperation between a supplier and an end user (Finne & Holmström, 2013), and their diverse supply-chain collaboration strategies. In some cases, suppliers adopt the role of value process organizers to support unexperienced customers and they go through all the process of identifying, activating, collecting and integrating resources to make the value creation possible (Sandin, 2015). On the other hand, manufacturing firms may also work as systems integrators since they have the best understanding of the service needs of their customers, while subsystem suppliers possess the resources and capabilities to fulfill those needs (Finne & Holmström, 2013). When a cooperative network exists and combines experience and knowledge from different industries, value co-creation during servitization is possible. This thesis studies the network conformed by a software service supplier as the subsystem supplier, a manufacturing firm as the integrator and the equipment user as the end customer.

In a more traditional view, value was created by the manufacturing firm with minimal interaction with the customers but nowadays it is possible to integrate the customers in any step of the value creation process (Mejtoft, 2011). Despite this evolution, the interaction with customers and a support service supplier has not yet been widely considered. The triadic collaboration between software firm–manufacturing firm–customer can be facilitated by different technologies such as wireless communication and analytical software tools. The use of external software tools is already considered in previous literature and the possibilities of remote monitoring of data collection have been analyzed. Nevertheless, there is not a clear path towards acquiring, developing and implementing this kind of tools. It was also noted that the focus has not included data ownership issues neither other clear benefits for the supplier besides increasing revenue through adding customer value.

The roles of manufacturing and software firms in industrial service delivery and their cooperation with each other and customers have been studied in separate contexts. Mezgár and Rauschecker (2014) covered the concept of a networked enterprise in manufacturing industry, but specifics on the partners involved in the network were not presented as the study had more of a technical focus looking to the benefits of cloud computing. The role of manufacturing firms pursuing service development has been analyzed jointly with the role of their customers, as the needs and requirements are established. For example, Sandin (2015) discusses the role of manufacturing firms and their customers in the aviation industry, where the services are built upon products already in use. Kucza and Gebauer (2011) studied in a multi-case setting the service organization and the implications of separating it from the strategy organization within

the manufacturing firm, which helped them understand how to respond to the customer's needs in a global setup.

Yang (2009) and Vezzetti (2009) focused on the software capabilities and tools needed to analyze lifecycle data in a manufacturing context, but as such the role of the software tool provider is not presented. The most evident gap in previous research is in evaluating and understanding the role of a software service provider in the network of industrial services. The closest study to address this thesis research objective is that of Finne & Holmström (2013), as the triadic relation in the service supply chain is considered in a case study, which showed how a subsystem supplier can provide services to the end user controlled by the integrator. This particular case could be applied in the context of a manufacturing firm being an integrator between the end customer and a software service provider. To summarize, the studies that better presented the roles of the firms in the service supply chain are showed in Table 5.

**Table 5.** *Summary of previous research on manufacturing firms' and software firms' network position in industrial service delivery.*

Author(s)	Sandin (2015)	Kucza & Gebauer (2011)	Finne & Holmström (2013)
<b>Methodology</b>	Multi-case study	Multi-case study	Single case study
<b>Studied role</b>	Customer-Manufacturing	Manufacturing	Subsystem supplier-Manufacturing
<b>Industry</b>	Aviation	Manufacturing companies	High-tech manufacturing company
<b>Key findings</b>	Partnership is highly valued but monetary benefits are hard to measure.  The cooperation co-creates value and suggestions are highly appreciated by customers.	Service organization should be in line with the market.  Separating product and service business	Manufacturing firms acts as an integrator, controlling the customer base and knowing their products.  The subsystem supplier possesses know-how and resources to service the products.  By bringing together different capabilities servitization is possible.

The previous table summarizes the findings regarding the roles of the elements in a triadic cooperation network. As seen, a comprehensive study of the network, considering a software service provider as a subsystem supplier to enable services utilizing ICT to process equipment lifecycle data in a manufacturing contest is missing. As the wider network is not yet considered thoroughly, the roles and responsibilities of the different stakeholders it not clear. The service possibilities enabled by lifecycle data have been considered in previous literature but the expectations from the manufacturing firms' point of view are not evident; neither has been the actual added value from software-based services provider. One of this thesis' objectives it to find the roles of software and manufacturing firms when delivering software-based services by filling the gaps left in the existing literature.

## 2.4. Summary

In spite of the multiple definitions and concepts available for the main issues related to this study, a base was created in this chapter to better understand the existing gaps and possibilities related to those topics. The purpose of this section is to synthesize the key concepts found in literature while identifying the gaps between the previous studies and the research questions posed in the first chapter. To simplify its analysis the key concepts are summarized and presented in Table 6, where the definitions are a combination of different sources presented earlier in the literature review.

**Table 6.** *Key concepts based on the literature review.*

Key concept	Description
<b>Business model</b>	The value proposition offered by a firm to create revenue. It involves four main elements: value proposition, revenue logic, delivery logic and key partners.
<b>Complex systems</b>	A solution conformed by products (equipment) and services (with or without the service component). In this context it includes the delivery of intelligent products and associated services.
<b>Industrial software-based services</b>	Services enabled by software and modern technologies like cloud computing and wireless communications. Remote monitoring systems and IoT are also considered as enablers of this type of services.
<b>Equipment's lifecycle data (ELD)</b>	A product has different stages in its lifecycle: design, factory, operations and end of life or disposal. During each phase there is data being generated which can be beneficial if it is stored and analyzed, this is considered ELD.



Firstly, the concept of business model was presented, identifying that the term has been often used as a buzzword but basically refers to the value proposition of a firm required to gain revenue. Four main elements were identified to be relevant for this study: value proposition, revenue logic, delivery logic and key partners. The focus of the business models in this thesis is the value proposition, as it was found that the revenue and delivery logics are practical issues. The partnership element is also very important because it is necessary to identify the roles and opportunities from two different perspectives: manufacturing and software industries.

Secondly, the concept of complex systems was also described, as it includes a value proposition of a physical product (i.e. industrial equipment) and services or extra processes. The business models related to this concept are not yet clear, although a business models classification for Product-Service Systems was found in literature. The business models are classified into product and service oriented, while the latter is subdivided use and result oriented. This classification was done focusing on single firms and it was not found a business model applicable for complex systems in collaborative networks. Moreover, the studies on complex systems have not focused on software-based services.

Software-based services in the industrial context involved normally SaaS and the trend is moving towards IoT and intelligent products. These concepts are highly connected with the lifecycle data of products, increasing the possibilities while technological advances in remote monitoring systems and machine-to-machine communication become more popular. These are hot topic nowadays, not only from an academic perspective but also from an industry perspective. Identifying the possibilities and challenges posed by new technologies in the B2B context is an opportunity for this study.

To summarize, Table 7 presents a summary of research opportunities based on the literature review performed in this chapter.

**Table 7.** *Identified gaps based on the literature review.*

Key concept	Research gaps
<b>Business model: key partners</b>	Traditional studies on business models studies do not consider the <b>key partners</b> as an element. From a collaborative network perspective of product and service providers (manufacturing + software firms), the <b>position and tasks</b> of each agent are not yet clear.
<b>Complex systems</b>	Complex systems research has included intelligent products perspective, but the benefits are studied from the customer perspective, missing the <b>motivation and benefits for suppliers</b> .
<b>Industrial software-based services</b>	Software-based services based on SaaS have been studied mainly in a B2C context.  The possibilities of using cloud computing and IoT in the industrial context to enable services in complex systems is still in an early stage of its studies. Thus, the <b>challenges</b> for the provision of industrial software-based services are not identified and moreover, solutions have not been explored thoroughly.
<b>Equipment's lifecycle data (ELD)</b>	Possible services related to the lifecycle of a product have been proposed in previous studies but the <b>opportunities based on suppliers' experience in different industries (i.e. manufacturing and software)</b> have not been identified.

This thesis contributes with the presentation of a framework based on the cooperation of equipment manufacturers and software-based service suppliers, when delivering services based on ELD. The methodology and empirical study of this thesis are presented in the following chapter. It will present a strategy to answer the research questions using the empirical information of the thesis.

### **3. RESEARCH METHOD AND MATERIAL**

This chapter's purpose is to explain and justify the nature of the thesis by elaborating on the reasons behind each research choice. The first part of the chapter presents the research methodology as a qualitative and interpretative study and the schedule followed. The qualitative data gathering path selected to understand the phenomenon described in this research consists of document and literature review from scientific and non-scientific sources plus empirical study based on semi-structured interviews. The later section presents details related to the data collection, such as nature of the firms and subjects involved in the study and issues evaluated.

#### **3.1. Research methodology and schedule**

Qualitative research is commonly used to learn how phenomenon occurs and it generally produces product and process improvement ideas (Zikmund et al., 2012). This thesis has been conducted as a qualitative explorative and interpretative research project, where the opinions of industry related individuals is analyzed and a personal opinion is formed based on the collected data, and built upon earlier knowledge and frameworks based on a comprehensive literature review.

As described by Gummesson (1993), there are five methods to conduct qualitative research: use of existing data, questionnaires, interviews, observation, and action science. Interviews were selected to better understand the current situation of software-based services and the opinions people in different industries had about it. Zikmund et al. (2012) summarized key disadvantages from conversations and semi-structured interviews, those being that the results are dependent on the researcher's interpretation and they lack flexibility respectively. Due to this, a conversation was conducted with the interviewees while the questions of the semi-structured were asked in a relaxed setting. This provided more flexibility to ask for in-depth answers to certain topics, while the whole interview was recorded for later analysis of the researcher.

By being part of the S4Fleet research program, access was granted to four companies offering software-based services and two manufacturing firms, all with an interest to get involved in data-oriented industrial services. The names and specific information about the companies is kept confidential to protect their privacy, therefore they are referred to as Company A-F.

The software companies to which accessed was gained varied in size and types of offers, allowing the identification of the opportunities and challenges of their

participation in a collaborative network according to their situation. Company A offers a broad range of products and services in a multinational context, serving small to big customers all over the world. Company B and D are medium size companies offering software solutions and services based on their own technologies, but also acquiring support technologies from other sources. Company E on the other hand offers a solution based on the technology of a secondary source but adds value by offering intensive consultancy services. The first three companies mentioned are used to work in partnerships with their customers and the latter one tends to work in a more transactional way.

Companies C and F in this study are big manufacturing firms with an international presence, delivering high-tech equipment and support services to offer innovative solutions to their customers. Both have developed and adapted technologies to acquire data from their equipment and are currently looking for business cases to develop new services for their customers. The participation of Company C is linked to a very particular business unit with a standardized piece of equipment, characterized by having a long life span and being idle most of the operational time, acting as a protection in case of anomalies in the system it is part of. The focus in Company F is on a product that enables manufacturing automation and allows online and offline data collection, depending on the customers' policies. Unlike Company C's case, Company F's product is constantly used and the products can be tailored to the customers' needs via the embedded software.

The study was completed in five stages, starting from mid-March 2015 and ending by late August 2015. Originally, the schedule was planned until October but the data collection was done rather fast due to the interest of the firms involved in the study. Thanks to the active participation of the involved companies and their fast replies, the data collection was almost ready before the second part of the empirical study. A general timeline of the research process is shown in Figure 12.



**Figure 12.** *Research timeline.*

During the first month of the project the literature review was conducted and a scheme for the interviews was prepared, after which the first part of the empirical studies took place by interviewing both software and manufacturing companies. After the data was collected, it was analyzed and the preliminary results were evaluated. The later part of analysis and empirical studies was conducted in the early fall while the results and conclusions were built during the last weeks of August.

### 3.2. Data collection and analysis

The method for data collection utilized in this study consisted of semi-structured interviews with manager level employees in software and manufacturing firms. There were two different outlines for the interviews to better fit the industry's context although they covered the same topics (see appendices). Depending on the respondent's background and information the questions had to be adapted and differed to some extent from session to session.

Altogether seventeen semi-structured interviews were held with company's personnel and the purpose was to identify and develop alternative business model scenarios for software-based services both from the perspective of manufacturing firms delivering complex systems, and software firms involved in software-based services. A summary of the sources of the data collection is presented in Table 8.

**Table 8.** *Summary of data collection sources.*

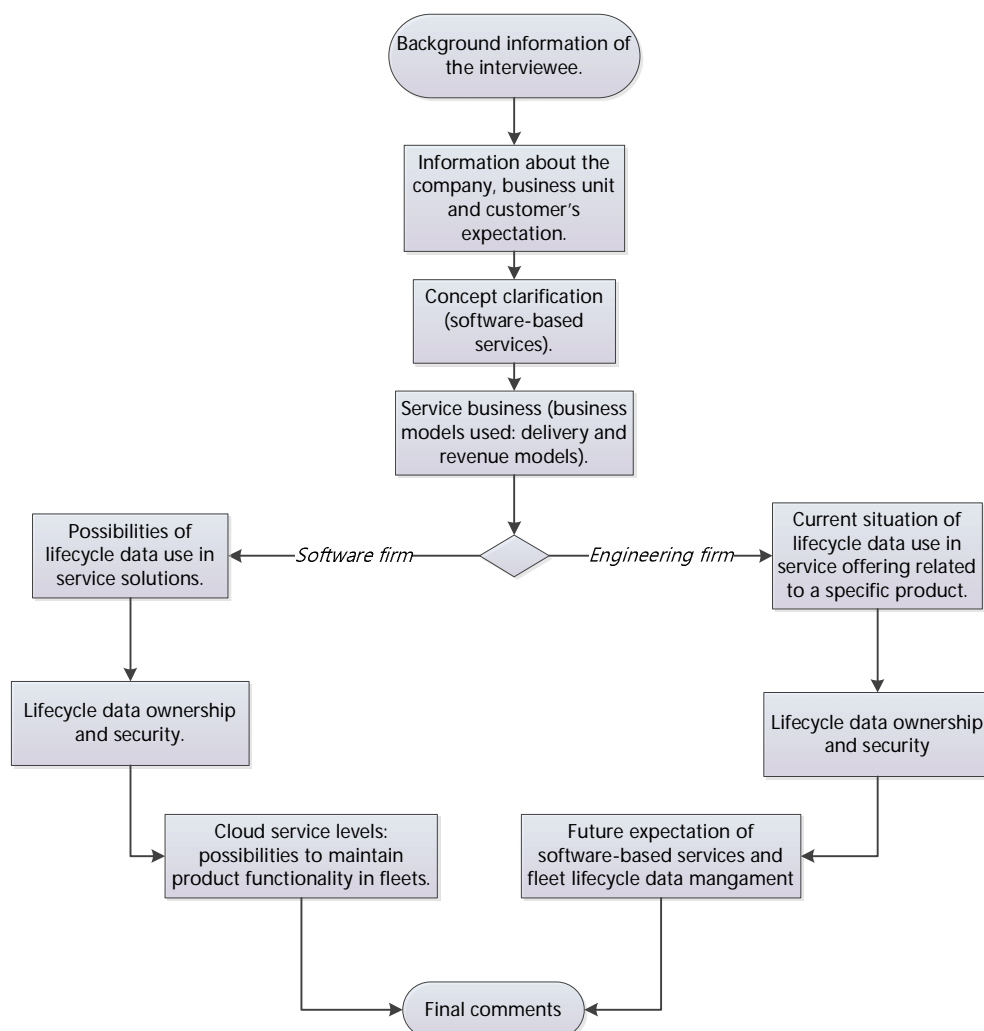
Company	Industry	Interviews	Respondents	Average duration
Company A	Software	4	4	39 min
Company B	Software	1	1	34 min
Company C	Manufacturing	8	8	37 min
Company D	Software	1	1	68 min
Company E	Software	1	1	68 min
Company F	Manufacturing	2	2	37 min

The interviewed companies were participating in the S4Fleet and the interviews took place in the companies' offices, allowing the interviewer to also observe the manufacturing firm's products and get a better understanding of how they function and their characteristics. Each of the interviews had one interviewee per session, them being personnel from different areas such as: product development, research and development, sales, lifecycle costs and risk assessment specialists, service developers and business analysts. Since the respondents held managerial positions they were able to provide deep insight about different operations and expectations in each of their departments related to the interests of this study.

More specifically, the answers provided by the manufacturing firms came from general area managers to line managers. Product and project managers answered the questions from both service and product's points of view. The focus of the personnel was on servitization, R&D and also software tools and development, despite the fact that the

companies were considered as manufacturing firms for the purposes of this study. On the other hand, in the software firms there was a relatively smaller sample compared to the respondents in the manufacturing firms due to the size of the companies. The interviewees held positions related to Internet of Things or Industrial Internet, business analytics, consulting and business solutions. All were related to data analytics and software-based services to a certain level.

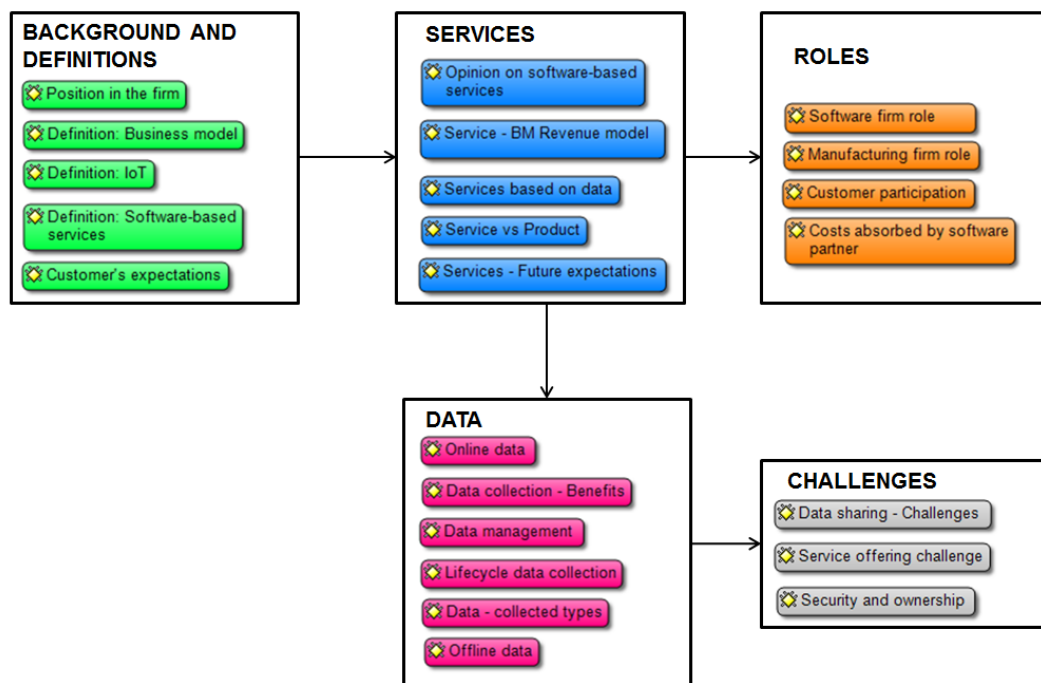
The questions asked related to what those companies wanted to achieve in the project and also related to the topic of this thesis. In the software companies, the interviews focused on identifying the possibilities for offering software-based services and different business models for them, as well as at generating software-based service ideas for complex data collection environments previously described by the manufacturing companies. In the manufacturing firms, the interviews aimed at identifying needs, possibilities and requirements for software-based services and to some extent, also at validating software-based service ideas provided by the software companies. Figure 13 shows the structure of the interviews.



**Figure 13.** *Topics structure of the interviews*

The questions regarding each topic were made in somewhat different order in each interview, as some of the interviewees' answers already contained answers to other topics or the interviewee could not answer a certain section. In other words, according to each respondent's role in the organization some questions were omitted and new ones were improvised according to the previous answers.

Each interview was audio recorded and later transcribed by an external provider. The transcripts were verified personally to fill in gaps and correct mistaken words. During the interviews, personal notes were made related to the ideas the interviewees provided. The data was content analyzed utilizing Atlas.ti, a qualitative data analysis software, using the reviewed transcripts. Firstly, the interviews were coded based on the main themes of this study. A second round of analysis allowed a more detailed coding and the creation of families to group the quotes that related to the same topic. The families were created based on the general topics of the interviews: background and definitions, challenges, data, roles, and services. Figure 14 shows the final classification of families and codes for the data analysis.



**Figure 14.** Families and codes of the data analysis.

The codes and the software facilitated the identification of common ideas between interviewees. The interview quotes presented in the results section were selected based on how well they illustrated a repeated answer or how they represented a very particular idea. Furthermore, the quotes were also analyzed by separating the opinions according to the industry the interviewee belonged; this allowed the comparison of perspectives according to each type of firm. The following chapter presents the findings after processing the collected data.

## 4. RESULTS

This section presents the most relevant results obtained through the empirical research of this thesis. The understanding of the interviewees related to some basic, but relevant concepts, is presented to set a background for the analysis of the results. The tasks of each firm in the triadic network are presented according to the expectations and experiences of the interviewees. The current situation and potential services based on equipment lifecycle data are also presented, considering the preconditions and challenges for their implementation. The results in this section are presented thematically rather than case specifically.

### 4.1. Background: customers' expectations and concept clarification

To start with, to establish a background when analyzing the responses of the interviewees, it was asked what each respondent thought were the expectations of their customers. Those expectations were compared with the current situation of service delivery to analyze potential service opportunities not yet covered. It was evident that in each kind of firm the target customers were different, so were their expectations. In the manufacturing firms' context, the equipment users are the main customers whereas in the software firms' context, the manufacturing firms are the target. The answers related to customers' expectations are shown in Table 9, based on the context of the respondents and the type of customer they serve.

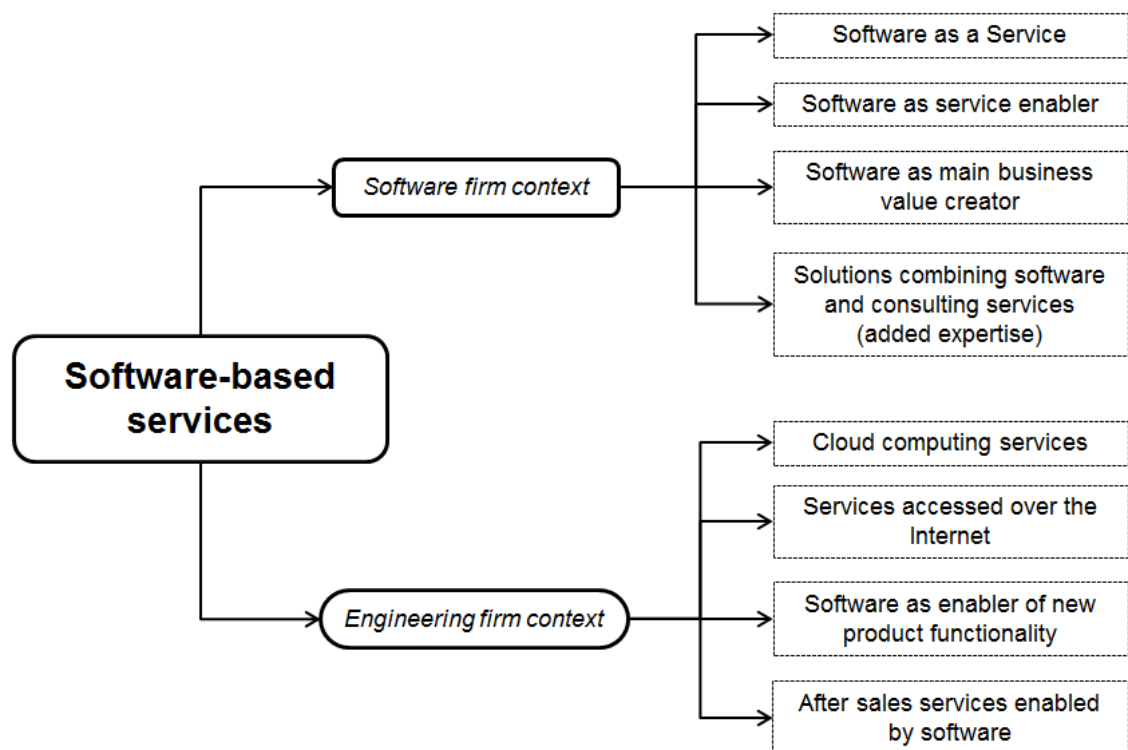
**Table 9.** *Customer's expectations according to the interviewees.*

Context	Customer	Expectations
Software firm	Manufacturing firm	✓ Excellence in quality and performance of products and services.
		✓ Long term partnership and trust.
		✓ Flexibility in the delivery and pricing according to the growth or needs of the customer.
		✓ Complete business solutions based on their expertise.
Manufacturing firm	End user	✓ Security for the investment.
		✓ Harmonization of the installed base.
		✓ Multiplatform and lighter versions of the software tools.
		✓ Easy upgrade of functionality in the products.



The expectations suggested by the software firms were validated by the respondents on the manufacturing firms. A trustful partnership was mentioned in the majority of the interviews to manufacturing firms' personnel as one of the key elements when selecting a software service provider. It was also confirmed that the manufacturing firms' interviewees expect that their software partners exploit their expertise in different areas to increase the value of their solutions (as suggested by the software firms). In general it seemed that the software firms had a clear idea about the expectations of their manufacturing customers. A limitation in this study was the lack of access to the end users of the manufacturing firms' equipment. Due to this, the expectations mentioned by the interviewees were not validated.

Furthermore, it was asked from the interviewees what they understood by software-based services. The motivation for this was to establish some precedent over which new business models could be built. As in the literature, there was no homogenous definition amongst the interviewees. The answers varied from very specific technical interpretation such as "embedded software related to cloud services" to "solutions where software is the core business value". Figure 15 shows a synthesis of the types of answers collected, depending on the kind of context the respondents were working in.



**Figure 15.** Definition of “software-based services” according to the interviewees and their contexts.

Despite the multiple definitions or approaches towards the concept of software-based services, all the respondents agreed that the software played a role to develop or access different services, mainly over the Internet and specifically over cloud services.

Examples such as ‘intelligent products enabling services based on data analyzed with software tools’ were mentioned a couple of times when elaborating on the possibilities enabled by software-based services. Particularly terms such as Internet of Things (IoT) and Industrial Internet were also brought up during the interviews, as the majority of the respondents in the software firms were in charge of that particular area.

IoT was defined by one person as “*the connection between the physical world (products or equipment) and digital world*”, where the physical items communicate between each other using sensors to collect information and the internet as the communication channel. The interviewee in Company D made a distinction between IoT and Industrial Internet: the market they target. IoT is related to consumer products and at least in the Finnish context, the idea of Industrial Internet is being coined for intelligent products communication in a B2B context.

With a clear idea of the customers’ expectations and the definition of software-based services, the rest of the topics can be covered. The position and tasks in B2B collaboration between firms were identified next and these are presented in the next section.

## **4.2. Industrial service delivery network: firms’ positions and tasks**

### **4.2.1. Potential value of a collaborative network**

Software industry has evolved from product to service orientation many years ago, therefore the software firms understand what manufacturing firms are going through now. Instead of ‘off-the-shelf’ products, software firms offer holistic solutions that can include consultation services, road-mapping and strategy work and other business related matters. Manufacturing firms are in a need to evolve to a business model that can allow them to cope with customers’ expectations and at the same time, increase their business share. This is the reason why manufacturing firms are heavily investing on creating new business cases supported by software-based services and the use of equipment lifecycle data. The challenge is to find benefits beyond the customer’s satisfaction that can also represent a new revenue stream for the manufacturing firms. This is why manufacturing firms seek for the software partner’s expertise. According to personnel in Company C, software firms are expected to provide new input and ideas, based on what they have seen in other industries or contexts.

During the interviews it was asked “*what are the expectations on the potential software partners for the manufacturing firms?*” and “*what are the roles each actor plays in a triadic network?*” The recurrent answer was that software firms provide solutions that can enable the manufacturing firms to offer services based on their products. They do not necessarily need to operate jointly forever, as they can provide the tools and

knowledge until the manufacturing firms have succeeded building their own capabilities supported by the software service providers. Company A's business analytics responsible stated...

*"They [the manufacturing firms] go out and say, we need you to help us build the capability. Typically they don't want to outsource it all because they still feel that it's part of their core value creation. They see the importance of the data, and the software based model. So what they use us for, is help them build their internal capability and accelerate it, so they will be quicker. So it would mean that we might run for instance analytic services for them for a year or two, helping them at the same time build their own capabilities."*

The majority of the software firms' interviewees shared this opinion, as they believe they can support the manufacturing firms rather than take over their operations related to services based on data. The collaborative network is based on understanding the capabilities and needs from the partners. From the perspective of the manufacturing firms, the knowledge about their customers' needs and their own systems and products is the key for a successful collaboration. It was suggested that even though the manufacturing firms have strong software development knowledge, they are constrained to a single industry, limiting their experience to their own field and not allowing them to see what the trends in other industries are. As the Business Development Director from Company E said, *"In every five years, you need to renew your own model and renew all your skills. Those lifecycles with these technologies are actually quite short, especially compared to the industrial systems that might have 30 years"*. It was also noted in one interview in Company F, that the industrial customers they serve tend to be more conservative than customers from other firms. This also influences the changes that can be done according to the trends in other areas and the experiences they have.

Furthermore, software firms' interviewees believe according to their experience that they can build capabilities and optimize the industrial processes to support the manufacturing firms and their customers. Optimization is not merely about reducing costs, but also about getting more out of the existing systems and processes. Nonetheless, costs can be positively affected as the software firms absorb the costs of long development of service capabilities in manufacturing firms by using pre-built solutions and tailoring them for the specific needs their partners have. Those costs primarily are allocated in the intellectual capital as said in all of the software firms' interviews, either by the software developers or the service and analytics consultants. In terms of physical infrastructure, the manufacturing firms have the possibility to build their own if desired i.e. servers to support the cloud services, but they can also rely on external partners to take care of that. This allows them to share the risk and take care of the investment costs. Table 10 summarizes the roles positions and key tasks of the manufacturing and software firms in a triadic collaboration network to provide services based on ELD.

**Table 10.** *Key tasks of the suppliers when delivering services based on equipment lifecycle data, according to the interviewees.*

Software firm roles	Manufacturing firm roles
<ul style="list-style-type: none"> <li>✓ Create solutions based on software tools (i.e. visualization, reports, analysis, etc.)</li> <li>✓ Help building capabilities</li> <li>✓ Provide insight from different industries</li> <li>✓ Enable new services' business models</li> </ul>	<ul style="list-style-type: none"> <li>✓ Understand the customer's needs</li> <li>✓ Provide equipment lifecycle data</li> <li>✓ Serve as an integrator, bring together software and equipment capabilities</li> </ul>

Building a cooperative network was considered as relevant by a couple of respondents and was seen as a larger network than just a triad. Having different providers with different expertise areas can enhance the service offering and improve the business possibilities of the manufacturing firms, while they also serve their customers better. As given in one interview from Company A: *“from the industrial manufacturer's point of view, they could be collecting data and then looking at their wider value chain, taking and providing some of that data for use of their partners who could then utilize that somehow to create more value, added to the value chain”*. The focus on the suggested added value was in enabling new services based on data, where all the firms involved had experience in a specific field and then they could exploit it to create services.

#### **4.2.2. Revenue and delivery models**

All of the interviewees in the software firms presented different revenue models when delivering their solutions. In Company E the pricing was evaluated for each customer; in Company A, Company B and Company D the price was dependent of the type and complexity of the solution. Nonetheless all of the interviewees have seen a transition to acquire the services bundled with the tangible product and have noticed the increasing interest on having flexibility for their payments (i.e. pay-as-you-go model and pay-per-use). Another important characteristic mentioned in the majority of the interviews, is that the pricing needs to be done fast and easy for the customers and for the firm.

It was suggested that the experiences in the software industry context could be translated to revenue models in the manufacturing industry. Currently, services in the manufacturing firms are normally charged as fixed-term quotas or subscriptions. An interviewee from Company C provided an example where a service that intends to collect and store lifecycle data is charged on yearly basis, without any restrictions on its use. The motivation to do it that way is to make the pricing as simple and clear for the customers and for the company itself. Similarly, Company F respondent mentioned that the current service offering is normally charged as a fixed maintenance quota, unless

there are extraordinary events that require an extra payment by the customer according to their service level agreement (SLA).

A minority of interviewees from the software firms suggested the illustration of benefits to define the pricing of the services. This means that by evaluating the equipment lifecycle data, manufacturing firms can offer services and present the potential benefits of using a particular service. Related to this, a person from Company A highlighted that this option can be challenging as the service business is constantly changing and forecasts are always prone to mistakes.

For both manufacturing firms, the services represent about 20% of their turnover and they are hoping to increase that percentage by offering new and more attractive services. The delivery of these services is also constrained to the characteristics of their equipment and customers. As explained in Chapter 3, the equipment supplied by Company C plays a critical role in the system it is installed but is rarely active unless there is a disturbance in the system. These characteristics have limited the service delivery according to all of the interviewees in the firm. Then as well Company F has encountered some limitations for the service delivery. According to one of the interviewees the customers they work with are conservative, making the introduction of new technologies for service delivery more challenging.

Exclusively considering the delivery of the software-based services, both manufacturing firms in this study have developed the technology to enable them. Following global trends, the companies are engaging into IoT and remote monitoring systems to deliver their software-based services. Sensors are included in the equipment and support services are offered via software in both manufacturing firms. For Company F particularly, the presence of remote communication tools and what is now known as IoT is not new, but it has not yet been exploited despite being there for more than a decade already.

What was expressed in the interviews is that the capabilities have been built using internal resources and external partners. Despite the participation of a different supplier, manufacturing firms have complete ownership of the software. This answered the question regarding the ownership of the software enabler when a sub-system supplier participated in its creation. In addition, after comparing the different opinions of the interviewees, it was concluded that it was not possible to define a unique delivery model to fit the idea of software-based services. It is mostly dependent on the characteristics of the equipment and the type of service that is offered. More detailed information about what is being delivered to the customers is now presented in the following section.

### 4.3. Software-based services using equipment lifecycle data

#### 4.3.1. Current situation

At the moment, most manufacturing firms build their services on top of their products, meaning that their services are still not independent from the equipment. This conditions the existence of the services on physical elements, instead of data and information. The manufacturing firms in this study have had some time analyzing possible business models enabled by equipment lifecycle data and have already started the servitization process. However, the services are more reactive than proactive, as stated by an employee of Company C *“if something breaks, we come and offer a service to fix it”*.

The two manufacturing firms in this study supply equipment that already allows data collection. In both cases, sharing the collected data with the manufacturers is up to the customers' policies and decisions. Most of the service expectations based on ELD from the manufacturing firms are connected to preventive maintenance, which was a recurrent topic in the majority of the interviews. One of the benefits for the manufacturing firms can be the cost reduction when maintenance is planned based on the collected data and failures can be prevented, as they would not need to send a technician to analyze what is the situation but instead could get that information remotely. On the customer side, they could reduce breakdown costs and time if they could know when a component or piece of equipment is more likely to fail and act accordingly. The current situation as explained by a respondent from Company C:

*“Now we more or less give just an error message and contact the customer support or the service organization, and then there's a man or woman travelling to the site and fixing the problem and then travelling back... more self-service oriented information could be implemented.”*

It was said in all the interviews that collecting equipment lifecycle data could be beneficial for the customers and manufacturers in terms of time and costs allocated to support services. Similarly, services related to changes on the configuration or components of the equipment could be also enabled. For example, tracking changes in the lifecycle of the equipment could benefit not only the support and maintenance, but also the update of its components and future service offerings based on the latest status. Unfortunately, this service offering has not been positioned successfully amongst customers in either of the manufacturing firms.

From the software firms' interviewees' point of view, the situation now allows them all to say they have participated in several projects related to software-based services. Besides only focusing on preventive maintenance, the recurrent option in the manufacturing context, services such as data analytics, data storage/transmission

services for up-grades and harmonization and installed base communication for operation's optimization were brought up amongst others as potential services in the manufacturing firms' context. Current trends according to the experts in the software firms are related to data analytics, to understand not only what the customers are doing really with the equipment but to provide better services and products in general.

#### **4.3.2. Expectations and possibilities**

The current situation in the two types of firms confirms that the experience from the software firms could broaden the possibilities of the manufacturing firms. As previously stated, most of the service offerings based on equipment lifecycle data from the manufacturing firms are connected to reactive actions. On the other hand, the expectation of the majority of the interviewees in manufacturing firms is to offer preventive maintenance. After analyzing the current situation and comparing both types of firms, it was asked what could be the possibilities regarding service offering based on equipment lifecycle data.

Manufacturing companies need to first get access to their customers' data, which could be translated into a partnership or stronger relation with them. Nevertheless, the consumers' goods industry has succeeded to get personal data from their users, even when the manufacturer is using dealers or distributors to get the products to the shelves. In this way, a future expectation in B2B market is to be able to get the data despite the distributors or third parties and lack of contact with the end customer. It was suggested by a couple of interviewees from Company C that having an online connection to a cloud platform, where the location and setup of the device is stored, could be a good solution. A possibility to ensure the customers are sharing this kind of information could be taken from the consumers' market experience: make the full functionality available when the product has been registered. As a benefit, customers could get new services better targeted to their needs.

Once the access to the data has been enabled, all of the interviewees agreed that there are almost endless possibilities of services to be offered. For example, manufacturing firms can offer better solutions for their customers according to their installed base and operations when they know how it has been used. This kind of expert's consulting and advice can not only optimize the customer's operations but can also allow the supplier to sell new or different equipment to the customer. Additionally, when the connection has been established to share the equipment's lifecycle data, upgrading services of the hardware and software in the equipment can be also done remotely. This can reduce costs of visiting the site or transporting the equipment to the factory, and can also allow the customer to harmonize its installed base. An employee at Company C mentioned that harmonizing the fleet is one of the main expectations of their customers because they want to have a fully compatible installed base without too many complications.

The upgrading of physical components of parts should be registered as part of the lifecycle data management. In this way the suppliers can know the configuration of the equipment and provide the components with the adequate configuration, reducing installation time and possibilities of error or malfunctions on the customer's side. At the same time, customers can benefit from updated information in monitoring systems, not only regarding their installed base but also about the disturbances or errors in the operations, the usage patterns and health of their equipment. Perhaps in a more technical side, but also mentioned during the interviews in Companies C and F, is the possibility to have monitoring tools on mobile gadgets such as tables and smartphones. Based on that kind of data, manufacturers can provide reporting services, for example when something has failed it could be identified what caused it. According to the answers of Company D's interviewee, monitoring services can be used to improve customer satisfaction and the data analytics as part of a new revenue stream.

A respondent from Company C said that the service offering possibilities has almost no limits, but what could hold it back is the impossibility to place a price tag to those services or to make them viable for the supplier. What was interpreted from the majority of the interviews is the possibility to see that not all revenues must come from the direct sales of the services, but can be from other actions enabled by the data generated through the services. For instance, suppliers can make better offers targeted to the customers' use patterns, the R&D department of the manufacturing firms can learn from error logs and reports shared from the customers' use cases. Also the possibility to analyze historical data can improve the warranty and service policy, saving costs for the manufacturing firms. These were only some of the ideas, mainly those that were brought up more than once by the interviewees in different firms.

Interviewees in the software firms had further experiences based on earlier cooperation with manufacturing companies and they gave examples of services that could be enabled by data. As each company differed in the type of solutions they had, their services ideas were slightly different. Three main categories of services were found: Customer service, Analytics and Quality assurance. Table 11 sums up the service possibilities suggested by the interviewees in the software firms.



**Table 11.** *Services based on data according to software firms' interviewees.*

<b>Analytics</b>	<b>Customer service</b>	<b>Quality Assurance</b>
Risk assessment	Operation support	Predictive maintenance
Process optimization	Fleet monitoring	Product quality feedback
Maintenance schedule optimization	Traceability to facilitate decommissioning	Product development
Performance indicators	Configurations storage (cloud services)	
	Use patterns report	

These three categories seemed to have evident benefits for the customers, but the realization of new revenue streams based on them still represents a challenge for the service developers in the manufacturing firms. For instance, in some of the services already implemented in manufacturing firm C, there was no monetary benefit as the services are given away for free or bundled with the equipment. However, this was used as a differentiator from the competition. For company F, the services are oriented to support and maintenance, therefore the revenues are constrained to the failure or upgrades of the equipment.

The suggested services in the table above are constrained to the types of data available. In all interviews it was asked “*what are the different possibilities of services based on the availability of data online and offline?*” and the answers were diverse. The interviewee from Company E emphasized the benefits of historical data, which can be collected “offline” or not in real time. This opinion was shared by a couple of persons in Company A, who said that as long as there is data to compare the current status, there is a possibility to create predictive analytics regarding lifecycle times. This analysis can improve the terms of warranties and the maintenance services. On the other hand, the online data was considered essential when there are critical processes associated to it. Company A’s respondent gave case examples from financial and aviation industries, where live data can determine the success and costs associated to a process. What was mentioned in all of the answers, is that online data can definitely impact the agility and speed of the organization

Depending on the type of process the equipment generating the data is present, the online and offline possibilities can determine the types of services associated to it. In each kind of industry the environment and operation conditions play an important role too when there is an interest to implement new industrial services based on equipment lifecycle data. This conditions create diverse challenges before the implementation of

services based in lifecycle data are possible. They are presented in more detail the following section.

### **4.3.3. Implementation challenges**

The equipment manufacturing firms are selling carry the most value to the customers and that has been the case for many years, making the transition to a product-service organization more complex. Different challenges were brought up during the interview sessions, where the most difficult was the realization of revenue via services when they are not the core offer from the firm. The pricing of services in the two manufacturing firms participating in this study has been an issue through time. As said by one of the managers in Company C *“How do we package all these services and put a price tag on it?”* It was then highlighted that the implementation of different services based on data was not due to lack of technological resources or motivation, but depended on the conditions specified by the customers and the difficulty to set an attractive price for the services.

Software firms are not only providing software solutions, but also provide the knowledge and experience of several industries with their services. It was mentioned in the interviews with software firms' personnel that even though the investment of resources may seem large in the beginning, the time and resources that are saved later on during the operations is compensated. Similarly that is how the majority of the interviewees see the evolution to servitization based on equipment lifecycle data: the manufacturing firms may feel that they need to invest in the beginning by providing services that may not generate revenues, but the possibilities once the customers are sharing the lifecycle data of their equipment can compensate for that initial struggle.

Often the challenges about servitization rely on the lack of direct input from the customers, as their opinions and expectations come from the product and project managers instead of straight from the equipment and service users. On the other hand, if distributors and third channels are involved, the collection of customers' expectations is even more complicated. A solution would be having an online connection to the equipment to collect data to understand what the current status from the device is, helping the development and delivery of new features and upgrades.

As said by the software and services manager in Company A: whenever possible, data should be collected so it can be used in the future as historical data and improve forecasts or whatever services are designed. A challenge then becomes the integration of different sources of data in all sorts of formats. This has been an issue from the manufacturing and software firms' perspective. But as mentioned in Company C, if they had a standard for the information some competitive advantage would be lost. It seems that there is currently no way around that challenge. From the technological point of

view, it is possible to integrate different data sources but it may slow down the process for their customers.

The access to data is highly connected with ownership and security issues. During the interviews it was asked from the manufacturing firms' respondents what were their thoughts related to the data security and ownership, as they showed their interest since the beginning of the study. For the whole sample, the data ownership was clear: the customer owns the data that is generated by their equipment. Therefore the challenge on the industrial services based on the analysis of lifecycle data relies on the possibility to get that information from the customers.

The customers seem reluctant to provide the equipment's data to their suppliers when requested. From the manufacturing point of view it was said that as a basic principle *"information shouldn't be available to other people, as a customer I would like to be in charge of who can access the data"*. Nevertheless, it was mentioned that when the support service teams of Companies C and F asked for a log or other kind of information of the equipment, the customers did not hesitate to share the data as they knew the objective. When that is the situation, customers do not mind sending the information via email or through some other cloud service that may not count with enough security measures. Particularly in Company F's case, customers enable the online connection to the equipment for as long as the support team requires it, sometimes taking days.

*"I'm not really sure about if that's kind of sensitive information. Because anyway, quite often they (the customers) are sending their configurations to us also over mail if they want to show that okay, 'we have some issue with this application, could you help us to get this correctly configured?' They send the configuration files to us, so I don't see that as a really critical."*

For instance, with the current software tools of Company C, some services based on data have been enabled but there are still expectations to increase the offer if the customers were more willing to share their information. Nowadays the collection of data is technically possible, but human factors have slowed the servitization process. Personally, the majority of the interviewees were not comfortable sharing information through the Internet, therefore they understood why in a business-to-business context the customer firms would not allow their information to be shared with their supplier.

Company C had a specific case where data could be collected already from the equipment and stored in a cloud service if the customer activated it, but it was not very appealing for the customers as they could not see where it would be used on. In Company F, there is a possibility to be always connected and sharing data to the support team, but it is often disabled until there is a malfunction and the customers require assistance due to security concerns

In short, the interviewees agreed that sharing the information may not be that critical if there is trust in what the company is going to do with it and if the customer does not have to do any extra effort. Customers are also willing to compromise in a way their security when the breakdown costs are higher than the risk of opening the connection for some time while the support teams work to fix their problems. This is strongly connected with the first issue mentioned in this section, as the price tag that is connected to the service package needs to be good enough for both the supplier and customer. As the interviewee in Company B mentioned, it is a cost vs. benefit analysis for both the customer and the supplier, which is the manufacturing firm in this case:

*“The customer is thinking about the potential pain and gain if they give the data or access to the data. What do we get if we give it? If that ratio is enough, meaning that they feel they get more benefit than, like negative things when they give it. That's typically so big problem as it is seen in the market... (for the manufacturing firm) you need to give something, especially in the beginning, you need to be giving something even if it is for free, to get access to the data, because everything starts from that.”*

That opinion was shared at least to a certain level in the software services context, as the interviewees suggest starting by sacrificing something or giving a service for free to then gain access to the data and build business cases on top of that. It was still remaining to know what kind of sacrifices are the manufacturing firms willing to do to get access to the data, as they have not yet seen the full potential of the servitization.

To sum up, the involved interviewees in both types of firms mentioned four main challenges: revenues realization of the services based on equipment data, equipment data acquisition (ownership), equipment data management (integration) and data security. It was also a shared opinion that these are issues related to perception rather than technical capabilities, therefore the creation of an attractive business model would help them overcome the challenges.

## 5. DISCUSSION

This thesis has focused on the delivery of software-based industrial services, which refers to services supported by software tools in the manufacturing industry. With the objective of identifying suitable business models, the different elements have been analyzed from previous literature and through interviews in software and manufacturing firms. The focus has been on services based on equipment lifecycle data, where software acts as the service enabler by transforming the data into valuable knowledge.

The findings are in line with what Tukker (2004) classified as results-oriented business model, since the industrial software-based services' value relies on the output of the process. According to the literature presented earlier, business models have four elements: value proposition, revenue logic delivery logic and key partners.

The following sections describe each of these elements to answer to the main research question...

*What kind of alternative business model can manufacturing companies use to provide software-based services using equipment lifecycle data?*

Particularly the element of key partners is analyzed deeply in order to answer to the first sub-question, regarding the tasks and position of each element of the service delivery network of industrial services based on ELD. The second research sub-question is answered by presenting a framework that covers the implementation challenges to enable and promote industrial software-based services, based on ELD. It was found that the creation of value and the delivery challenges correspond to previous studies (e.g. Brax, 2005; Gebauer, 2007; Oliva & Kallenberg, 2003; Malleret, 2006).

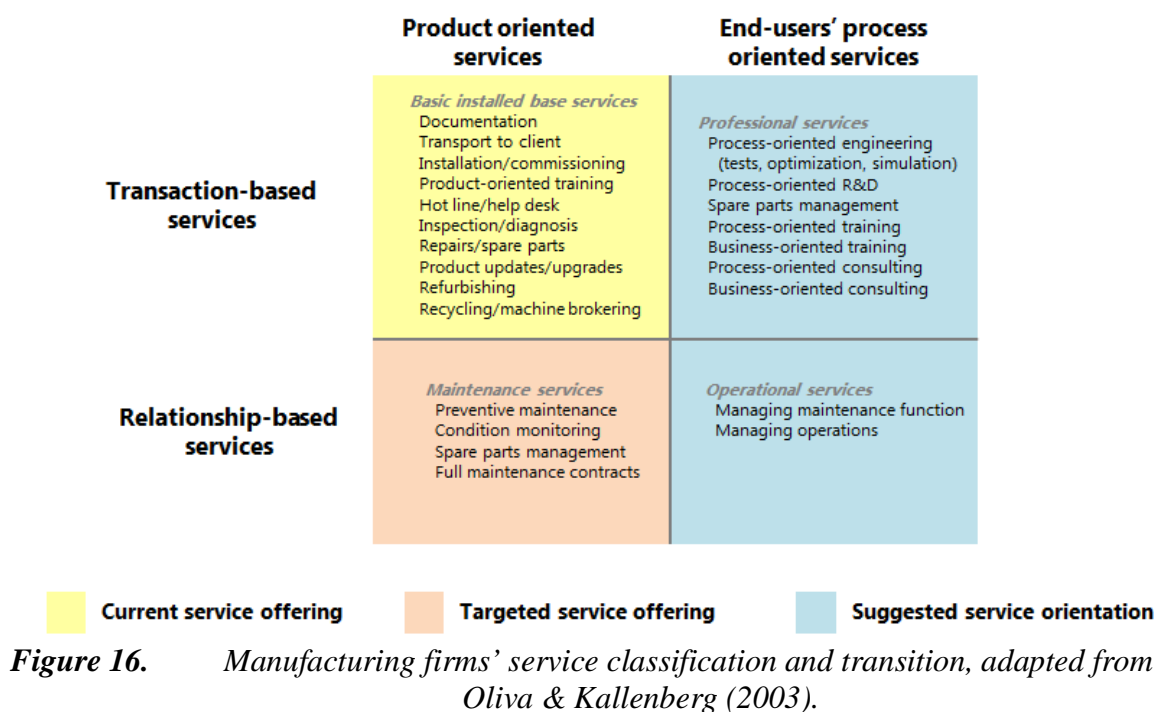
### 5.1. Alternative business model for industrial software-based services

#### 5.1.1. Value proposition in complex systems

The value proposition is the core element of the business model, as it defines if the offer to the market is attractive enough to earn something back. The manufacturing firms in this study expressed their interest in different kinds of services, which base element in most cases was the product lifecycle data. The results show that the manufacturing firms' current services dominantly cover preventive maintenance, R&D processes of product development and process optimization inside the firms and for the customer, and such services are located in the second and third level when compared with the ones

proposed by Kucza and Gebauer (2011) based on the knowledge intensity of services. Visualization and analysis tools were mentioned to create cost-benefit analysis, present performance indicators and visualize benefits. When compared with the services proposed by Yang et al. (2009), the preventive maintenance was again mentioned, as well as the use patterns report and better forecast to optimize the maintenance schedule.

Changing the focus to services that are more data driven than product dependent represents a big challenge (Brax, 2005). What is suggested by the software firms and also embraced by the expectations of the manufacturing firms is a transition to reactive services. Already the interviews and earlier literature emphasize that there are more possibilities than only preventive maintenance, in services based on ELD. This kind of service focus is related to the equipment users' processes which is different to the current focus from the manufacturing firms' service development. Considering the service classification by Oliva & Kallenberg (2003) the service orientation manufacturing firms should follow according to the service possibilities enabled by collection of ELD is shown in Figure 16.



The current service offering is related to transaction-based and service oriented services, what manufacturing firms classify as after-sales services or lifecycle services. Most of their efforts according to the interviewees have been concentrated on offering all kinds of maintenance services, which fall in the category of relationship-based and product oriented. As mentioned above, it is suggested that the service offering based on ELD focuses on services that can also benefit the end-users' processes.

Primarily the software providers emphasized many kinds of services (e.g. Risk assessment; Operation support; Monitoring of the installed base of equipment;

Traceability to facilitate decommissioning; Configurations storage (cloud services); Product quality feedback; e.g. Oliva & Kallenberg 2003; Kucza & Gebauer, 2011, Yang et al., 2009) that are not, yet actively used by manufacturing firms. As remarked in the picture above, professional services and maintenance services could be the best combination to provide services and utilized ELD. The basic installed base service can coexist with them and could benefit too from the data collected from the equipment.

These services seem to fit the customer expectations suggested by the interviewees in the manufacturing firms, nevertheless there was no direct contact with the customers to confirm these assumptions. Moreover, the services are developed based on the equipment lifecycle data created and normally owned by the end user. This means that before the services can be delivered, customers need to be convinced about the value created when sharing the information. In agreement with Brax (2005), the results provided by the software firm interviewees emphasize the good communication needed between the manufacturer and their customers to become partners in value co-creation.

Despite the raising interest from the manufacturing firms in the study and the potential software service providers, there are questions unsolved regarding how these services can be enabled and promoted. Bigger concerns are those related with the realization of value (i.e. creating new revenue streams based on the services). The following section presents the ideas generated through the empirical study while contrasted with the existing literature.

### **5.1.2. Revenue and delivery logic**

As confirmed by the empirical study, flexible payment models are trending (Weinhardt et al., 2009; Laplante et al., 2008; Cusumano, 2008) and customers are expecting more than a physical product. These trends are finding their way also in the manufacturing context, where customers expect an integral solution rather than just a piece of equipment. The key factor to define the revenue and delivery models is the type of services the firms are offering: traditional services call for traditional pricing models. The possibilities of delivering software-based services based on lifecycle data have increased as the technology advances, representing a possibility to create further value to the involved parties. With SaaS and wireless communications as enablers and delivery channels, new services can be built based on lifecycle data.

Literature has barely analyzed the revenue and delivery models in the manufacturing context for services in complex systems. This is most likely connected to the practical issues surrounding each offer, and the great amount of particular characteristics of each service context. On the other hand, the servitization evolution of the software industry has created a fair amount of studies analyzing benefits of each model and the current trends as shown in Table 3 of this thesis. It was understood from the interviews that the peculiarities of each industry, customer and context make the revenue and delivery

models very practical, thus a generalization is almost impossible. Despite this, there was a constant answer in the majority of the interviews, regardless of the industry, which says that pricing is expected to be *flexible, fast and easy*. It requires flexibility to fit the customer's needs for customization, needs to be fast to respond quickly to the market changes, and needs to be easy to understand for the customer and to implement for the supplier.

By analyzing some of the models available in the literature (particularly from the software industry), and the suggestions or expectations of the interviewees, a set of alternatives are presented. Table 12 presents the possibilities that could best fit the context of industrial services, evaluating them based on the desired criteria explained above.

**Table 12.** *Revenue model alternatives evaluation*

Revenue model	Type	Description	Flexible	Fast	Easy
<b>Subscription</b>	Fix	The customers pay a service quota, generally for long periods (from months to years)		X	X
<b>Transactional</b>	Fix or dynamic	Each service represents a new charge to the customer.	X		
<b>Usage fees</b>	Dynamic	The service is payed according to the usage. It can include fix prices or they can be different rates according to the level of use.	X		X
<b>Freemium</b>	Fix	Offer certain capabilities for free, while improved features can be purchased on the go.	X		X
<b>Benefit-based pricing</b>	Dynamic	Based on the value added to the customer's business model. It is mandatory to have a strong relation with the customer to be able to measure the potential benefits.	X		

The models presented above were analyzed considering previous literature and the expectations of the manufacturing firms to price their services. As seen, none of the models fit the three conditions expected by the manufacturing firms, although each of them could bring different benefits if implemented. To start with, subscription models are the traditional pricing strategy for Companies C and F as described in the results section. If a change in the value proposition is pursued, it could be convenient to



reevaluate if this is the model that wants to be followed. Transactional models are sometimes used nowadays, particularly when the customers of the manufacturing firms required specialized services. This model offers flexibility, but requires the evaluation of the costs and possible revenue very often on the supplier's side, thus not being fast or easy to implement. Usage and freemium fees are directly adapted from the software industry and are less linked to the equipment than the previous two models. These options are relevant when pursuing a results-oriented business model, as the customers can be hooked to the services by providing them first positive outcomes. Lastly, a benefit-based pricing may not fit the expected criteria from the majority of the respondents, but it was brought up during the interviews. This kind of model requires a close relation with the customer in traditional service business, but the use of equipment lifecycle data is a key element to implement this kind of service if a partnership has not previously existed, as the supplier (i.e. manufacturing firm) needs access to historical data to better forecast the potential benefits.

Related to the delivery logic, fewer alternatives that could be presented in a general level were found. Software-based services include the equipment supplied by the manufacturer and software element that enables some result. The traditional alternative is where the manufacturing firm delivers the service based only on its own capabilities and resources. This kind of delivery logic fits the current and traditional services but the proposed services in the previous section demand for more specialized knowledge. The software firms can indirectly serve the customers by providing the tools to obtain the desired result in their processes. This particular option is strongly linked with the "key partners" element of the business model, therefore it is discussed more thoroughly in the following section.

### **5.1.3. Key partners**

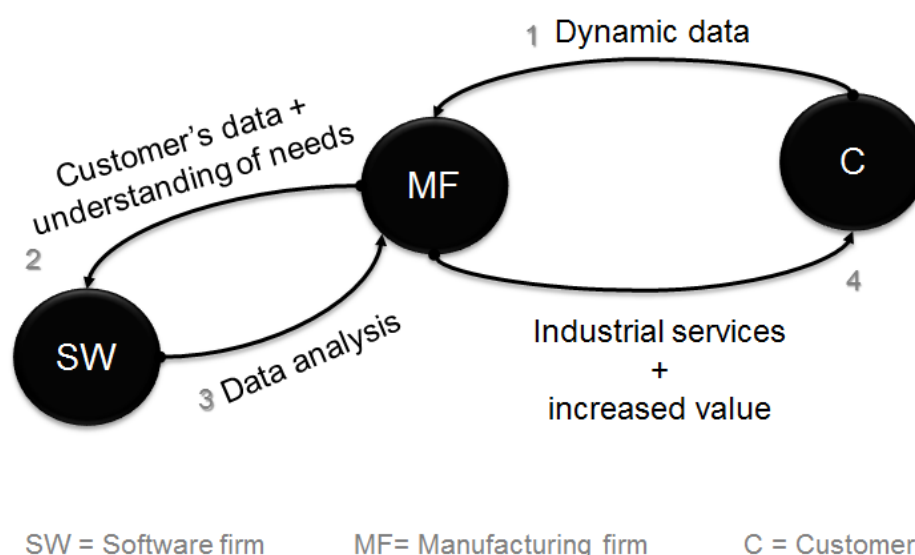
The first research sub-question dealt with the division of tasks between the manufacturing firm and the software provider, in the delivery of services based on equipment lifecycle data. This is why the key partners were added to the traditional business model elements' classification. This element was only found on the BM canvas presented by Osterwalder & Pigneur (2010) and its recent inclusion can be part of the shift between the traditional model with minimal interaction with customers (Mejtoft, 2011) and the current trends of value co-creation (Brax, 2005).

The results showed that the expectations on the network position and tasks of the manufacturing firms are generally consistent with the key findings presented earlier in the literature, but novelty lies in the empirical evidence about the positions and tasks of the different companies in the service triad (software service provider, manufacturer and customer). As a contrast to the findings presented by Finne & Holmström (2013), the results in this study propose that the manufacturing firm acts as the integrator between the customer sharing ELD and the software firm, while also acting as the only direct

service supplier to the customer. The results in this study also suggest that the subsystem supplier (i.e. software firm) acts as a partner in the co-creation of services besides providing the ICT tools for ELD processing.

Due to the nature of the manufacturing firms' environment, software firms act as enablers, meaning their cooperation can end when the capabilities to provide services based on ELD have been built. Previous studies considering the analysis of data to enable services do not analyze the tasks that each company has in the delivery network. The previous literature covers the dyadic cooperation between manufacturer and customer (Sandin, 2015; Kucza and Gebauer, 2011) but do not look into the cooperation of a support service supplier (Finne & Holmström, 2013), even when talking about software tools to analyze the data (Yang et al., 2009; Vezzetti, 2009). This study contributes with the perspective of the software firm as a prospective subsystem supplier, differentiating this study from the previous literature.

The triadic setting presented in Figure 17 positions manufacturing firms as integrators and they not only interact with customers as mentioned in Mejtoft (2011), but also with a support service supplier in the successful use of equipment lifecycle data in industrial services.



**Figure 17.** *Triadic collaboration model between service suppliers and customer.*

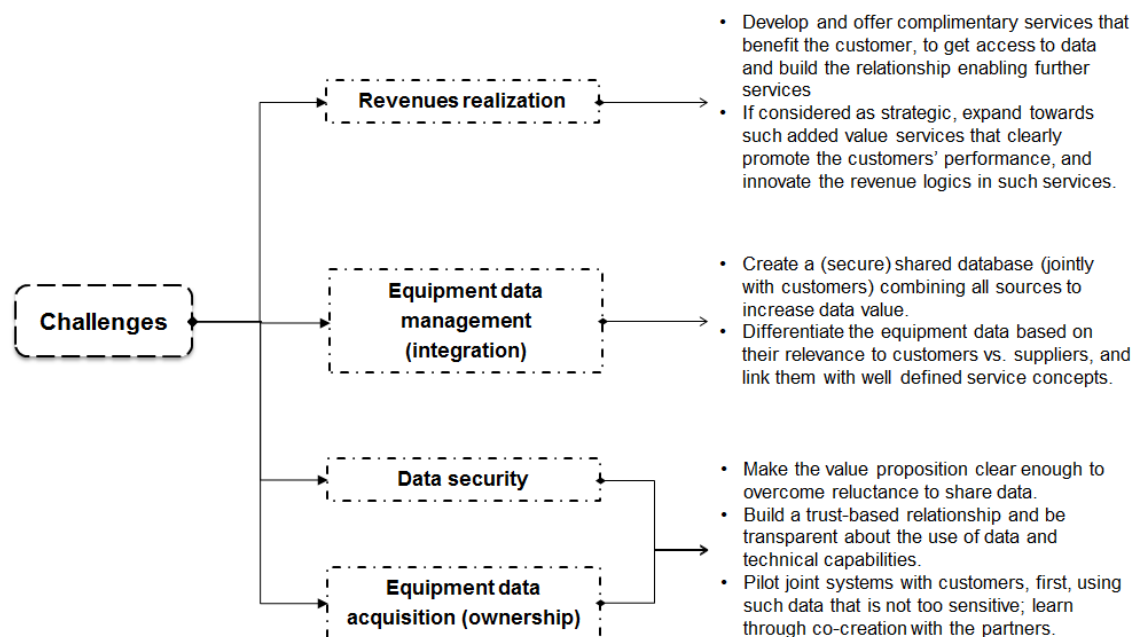
Deviating from the findings of Finne & Holmström (2013) where manufacturing providers cooperated with service providers in a direct supply chain toward the customers, the subsystem (software) supplier does not need to aim to keep in touch with the end customer, as the manufacturing firm integrates the software services and the customer needs. The triadic collaboration between software firm, manufacturing firm and customer is facilitated by different technologies such as wireless communication and analytical software tools, like the PLM system explained by Yang et al. (2007). The

customer's equipment lifecycle data is collected and sent to the manufacturing firm that shares it with the software-based services supplier according to the customer needs. The software-based service supplier analyzes the data based on its experience in other industries and environments and can propose new services, different to the traditional approach of preventive maintenance.

## 5.2. Conditions for industrial service promotion based on ELD

The last research question considers the key partners in the business model as part of the service delivery network. This section answers how can industrial services based on ELD can be promoted and enabled by the cooperation between firms. It was seen already in the empirical study that the manufacturing firms have potential to promote the ELD-based services even more widely. Various conditions need to be met to enable the use of ELD in services and ensure service business success. While the technical capabilities and requirements have been analyzed as in Vezzetti (2009), it is needed to overcome some other issues too. Mezgár & Rauschecker (2014) presented the main challenges but did not proposed steps to solve them.

This thesis contribution is the identification of four main challenges that need to be solved to enable and promote software-based industrial services using ELD, particularly when considering the collaboration between manufacturing and software suppliers in a network. These challenges and potential solutions are presented in Figure 18.



**Figure 18.** *Implementation challenges and potential solutions (particularly for manufacturing firms).*

The main challenges for enabling industrial services based on ELD are those related with the acquisition of the equipment lifecycle data to enable the services. It has been emphasized that the technical capabilities to keep the data secure are already available and previous studies can confirm that. Therefore the limitations to offer services based on ELD are due to human preferences and decisions, meaning that the security issues could be solved when there is an attractive business offer from the manufacturing firm based on clearly stating what the collected data can be used for.

In Sandin (2015) a key finding was that monetary benefits are hard to measure in a partnership such as the one needed in this triadic collaboration. This study suggests that it is possible to measure the monetary benefits, for example when processes are being optimized through data analysis and costs are saved when R&D utilized historical data to update the equipment. If these benefits are clearly transmitted to the customers and they are convincing enough, the implementation of services based on ELD could be possible despite the traditional hesitations to share the data. This kind of issue is also related to the potential benefit-based revenue logic.

Manufacturing firms may need to be willing to give away something to attain greater benefits and get the end customers on board to enable the proposed services based on ELD. During a couple of software firms interviews, there were specific examples given from electricity and media industries where the companies started by giving away some services based on data to ensure customer loyalty, which later on enabled them to build more services on top of them. Giving the opportunity for the final customers to monitor their equipment or processes can enable the suppliers to get access to data and also understand the real use of their equipment without making big investments. Through these kinds of examples in other industries and their successful implementation of services based on data, software partners can provide a company-specific offer to the manufacturing firms to develop a new service business based on their equipment lifecycle.

### **5.3. Synthesis**

As described in the previous sections of this chapter, most of the findings from the empirical study are consistent with the existing literature. Based on the idea of a results-oriented business model and a proactive service offering, some alternatives have been presented. The novelty added in this thesis is particularly focused on the value proposition and the key tasks and position of a subsystem (software) supplier as a key partner for service delivery, although the revenue logic was also described based on previous studies in the software service industry.

The proposed business model aims at offering a value proposition that is process-oriented instead of product-oriented regarding and that integrates different partners to deliver it. Despite the transition is moving towards the end-users' processes, it does not

mean that purely product oriented services should be discarded or that the maintenance services are not important, but the suggestion is that these new services can add more value to the network. The goal is to create services that the customer would perceive as proactive instead of reactive.

It is also emphasized that the revenue and delivery logic attached to these new services is dependent on the type of equipment, type of customers and environment's conditions of the industry or context. Even though the selection of the revenue logic is dependent on a lot of particular conditions, five options were presented and evaluated according to the main characteristics desired according to the interviewees. This is perhaps the element which study had more limitations, as the literature was scarce and the opinions and current situations were so variable.

Lastly, the delivery of software-based industrial systems, particularly those enabled by equipment lifecycle data, call for the participation of subsystem suppliers. This study presents a triadic cooperation network that uses the manufacturing firm as the center of the network, serving the position of an integrator. The manufacturer combines its knowledge about the customer needs, its relation with the customer and the unprocessed equipment's lifecycle data (provided by the customer) and the software tools and experience. The software service provider is considered as an enabler since its main task is to support the capabilities for the manufacturing firm to provide new services based on the acquired equipment lifecycle data. As mentioned, the customer's participation as the data provider is a key factor to access the ELD, as normally the customer owns the equipment lifecycle data.

To finalize, a synthesis of the discussion chapter is presented in Table 13.

**Table 13.** *Results-oriented business model for software-based services in complex systems.*

<b>Goal</b>	Proactive service business
<b>Value proposition</b>	Less product-centric services (e.g. maintenance service, help desk, commissioning, diagnosis, etc.) and more <b>process-oriented services</b> (e.g. process and business oriented consulting and training, preventive maintenance and diagnosis, process optimization, process-oriented R&D, remote monitoring, etc.).
<b>Revenue logic</b>	<p>Revenue logic alternatives are conditioned to the type of service offered and the delivery model.</p> <p>Subscription model is suggested for the traditional product-centric services.</p> <p>For process-centric services that require the access to the equipment's data, it is suggested to follow a <b>freemium approach or even a benefit-based pricing</b>. This is based on the assumption that the customers' participation is linked to how easy they can realize the advantages of sharing their data to accept the security and ownership risks.</p>
<b>Key partners</b>	<p>Value co-creation network based on the collaboration of manufacturing firms as <b>integrators</b> and the software companies as <b>enablers</b>.</p> <p>Customers' participation is the main concern, hence a trust relation should be built as suggested in section 5.2</p>

These elements can provide set of alternatives to develop a business model that fit its own context. Further research is needed to find the parameters and choices related to the delivery of these services.

## 6. CONCLUSIONS

### 6.1. Meeting the objectives

Servitization is a process that requires rethinking the business models of manufacturing firms, aiming to cope with the increasing competition in challenges consequence of globalization. Part of the changes in the business model is establishing a network that allows adding value to the service offering. This thesis studied the elements to build an attractive business model to offer software-based industrial services enabled by equipment lifecycle data, and the network positions and tasks of manufacturing and software firms delivering those services. The use of equipment lifecycle data was chosen because of the increasing relevance of systems to manage and process it, and the service possibilities enabled by it.

Particularly for manufacturing firms, the use of equipment lifecycle data can increase the amount of potential services and create new revenue streams while having more satisfied customers. It was noticed that for most literature and even for the manufacturing firms involved in the study, servitization is now bound to the physical equipment and the emphasis has been in maintenance services (also defined in the industry as “lifecycle services” and “after-sales services”). By experiencing the transition from product to service orientation themselves and working with customers in other industries, software service providers have brought attention to other types of services to complement the current idea of servitization in the manufacturing context.

To answer the main research question of this thesis, literature was explored starting from the definition of a business model and its elements. After considering the different opinions around the topic, four elements were considered as the guidelines for the potential business model proposed in this thesis: value proposition, revenue logic, delivery logic, and key partners. Business models in the software industry were also analyzed to explore background of servitization with software as a fundamental part of the offer. With the background literature, the experiences and expectations regarding each element of the business model were analyzed in the interviews with the companies’ employees.

The business model proposed for software-based services in complex systems based its value on services enabled by ELD. These services are not necessarily bound to the equipment as the data can be used to enable services based on the customer’s processes, while they can also create value for the manufacturer. This last point is relevant because previous studies have focused on the benefits for the customers, neglecting the

supplier's point of view. Related to the revenue and delivery logic, it was found that there are plenty of possibilities and the election should be based on each particular case's characteristics. Nevertheless it was found that flexibility for the customer is a key feature to make it attractive, as well as the rapidness to develop it and the easiness to understand and deliver the services.

The last element of the business model was key partners, recently introduced in the literature but not studied thoroughly from a perspective different than customer-supplier relation. The different points of view of manufacturing firms and software service providers were studied and their position and tasks in a triadic cooperation network were identified to answer the first sub-question of the thesis. The network is based on the idea where the customers utilizing the manufacturing firms' equipment provide the lifecycle data to the manufacturing firms to process and enrich it, enabled by a software subsystem supplier. In other words, manufacturing firms act as integrators and service providers at the same time, while the software firms help the integrator to build its own capabilities and develop new valuable services.

Lastly, the empirical study allowed the comparison and consolidation of the different perspective of the manufacturing and software firms. This answered the last question of this research about how the firms in the delivery network enable the software-based services using ELD. Four main challenges were identified based on the experience of the manufacturing firms and existing literature: revenues realization, equipment data management, data security and equipment data acquisition. With the input from the software firms, potential solutions to improve the conditions for servitization based on ELD were suggested.

It is concluded that the participation of external software suppliers can benefit the service delivery in the manufacturing industry. Despite the high technological development in manufacturing firms, the lack of experience in a larger context from different industries may narrow the view of service possibilities. Software firms can add fresh ideas to the service delivery network to enable and promote services based on ELD. With a clear and attractive service offer of the manufacturing firms, customers might be willing to oversee the security and ownership concerns related to sharing their equipment's data.

## **6.2. Limitations and implications for future research**

Despite meeting the objectives, this study was subject to some limitations that affect its validity. First of all, the literature review did not address exactly the same issue studied in the thesis. Partially this is because of the increasing but still novel interest about collection and use of equipment lifecycle data for service development. There were no previous studies addressing specifically the phenomena of suppliers' collaboration in



the co-creation of value in the delivery of software-based services. It was challenging to find specific cases addressing the main interests of the study.

Secondly, as a result of the empirical research methodology selection, this study was limited to the interpretation and expectations of the different stakeholders in a relatively small sample of companies. Interviews were the main source of empirical data and are prone to subjectivity from the interviewer and interviewee. To reduce the misinterpretations and affect the least possible the results, questions regarding the main concepts of this study were asked to build a background framework. In this way the context of the phenomena studied was less susceptible to misunderstandings.

Connected to this, the amount of people involved in the interviews was limited. Particularly in the software firms, the interviews were conducted with only one person, limiting the views to their own perspective. This was understandable because of the companies' size but including other employees rather than only managers could improve the sample.

Further research could include a more thorough empirical case study to analyze the viability of the business model and suggestions to overcome the identified challenges. Similarly, it is emphasized that the lack of customer participation makes this research biased to what the suppliers perceive. Integrating customer's point of view could be a next step to verify the assumptions made by the interviewees in the suppliers firms

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## **APPENDICES (2 PIECES)**

Appendix 1. Interview frame for manufacturing firms.

Appendix 2. Interview frame for software firms.

# **APPENDIX 1: INTERVIEW FRAME FOR MANUFACTURING FIRMS.**

## **Background information**

- a) Position in the company
- b) Job description
- c) How long and in which positions have you worked for the company?
- d) How long have you worked in the industry or similar fields?

## **1- Information about the company/business unit and customers' expectations**

- a) What does the company and business unit do?
- b) How would you describe the core competence of the company?
- c) How is the competition in your industry?
- d) Who are your customers? SMEs or big companies? Many or few key customers?
- e) How many international customers do you have? In which geographical areas?
- f) What do you think the customers expect from the company?
- g) How do you discover those expectations?
- h) What do you consider to be the key challenges in your business?

## **2- Service business**

- a) What kind of services do you provide to your customers?
- b) How important you think services are for the company's turnover?
- c) Do you believe service business is important for the performance of the company now? Why?
- d) Could it be important in the future?
- e) What would you say are the steps to identify opportunities and develop new services for your customers?

## **3- Software-based service solutions**

### **Concept clarification**

- a) What is understood by: lifecycle data, fleet, software-based services?

### **Current situation**

- a) What kind of software - related to the machinery - are you using or is implemented in your products?
- b) Who owns this software? How was it developed or selected?
- c) Which functionalities do this software has?
- d) Is the company offering software-based services based on those functionalities?  
If so, which types of software-based service solutions the company offers?
- e) Are there any important challenges to overcome or any room for improvement?
- f) Which are the motivations of delivering these types of services for the company and the customers?
- g) Have you seen improvement in the performance of your customers?

- h) Have you seen improvement in the performance of your company with this kind of offerings?

#### Service design

- a) Who designs those services?
- b) For the development of these solutions, are partners needed in association with the software for the machines?

#### *If yes:*

- i. What kinds of partners are needed? How are the partners selected and how they contribute to the process?
- ii. Who should deliver the services when partners are involved?

#### *If not:*

- iii. How can the company deal with the process creation and delivery based on its own capabilities?

#### Service offering

- a) k) How are these services offered at the moment?
- b) l) Have there been any changes in the process during the past years?
- c) m) What is the sell process of software-based services?
- d) n) Do you believe it has been successful so far? Why?

### **4- Lifecycle data use in service solutions**

- a) Do you manage or obtain in a way product lifecycle data?

#### *If yes:*

- iv. How? What do you do to process the data?
- v. What was the motivation to start using it?
- vi. Has it been a business enabler for your company? Why?
- vii. What are the future possibilities in this area?
- viii. How can you ensure the security of the data?
- ix. What are the problems, risks and constraints of these solutions?

#### *If not:*

- i. Do you think that lifecycle data management could be delivered by your company? Why?
- ii. How can this new form of service delivery change your business model?
- iii. Do you believe this could impact the market share? How?
- iv. What would be the problems, risks and constraints of these solutions?

### **5. Future of software-based services // Fleet lifecycle data management**

- a) What kind of information is valuable from the fleet lifecycle data point of view?
- b) How can this data help in risk management? Forecasting?
- c) Which are the main needs and opportunities regarding software services?
- d) Is there anything you would like to see related to software-based services?

Do you have any suggestions or comments related to interview?



## **APPENDIX 2: INTERVIEW FRAME FOR SOFTWARE FIRMS.**

### **Background information**

- a) Position in the company
- b) Job description
- c) How long and in which positions have you worked for the company?
- d) How long have you worked in the industry or similar fields?

### **1- Information about the company and customers' expectations**

- a) What does the company and business unit do?
- b) How would you describe the core competence of the company?
- c) Who are your customers? SMEs or big companies? Many or few key customers?
- d) Are your solutions provided mainly as a product or as a service?
- e) What do you think the customers expect from the company?
- f) How do you discover those expectations?

### **2. Concept clarifications**

- a) Can you define “software enabled service”, “software-based service” and “software as a service”?
- b) In a manufacturing environment, what do you consider to be “lifecycle data”?

### **3- Service business**

- a) Where are the main costs allocated when designing software services? (Customization?)
- b) Software is intangible, so what do you believe customers consider when paying for software services?
- c) How is the company selling those software services? (i.e. licensing, rental model, pay per use...)
- d) Do you believe that this revenue model has been successful so far? Why?
- e) How the delivery process works? (i.e. cloud, own infrastructure, hybrid...)
- f) Which have been the main challenges when offering software as a service? Why?

### **4- Lifecycle data use in service solutions**

- a) Do you have any solutions to manage product lifecycle data? What kind of solutions?

*If yes, from a specific case:*

- i. What was the motivation to start developing it/them?
- ii. How do you define the innovation your firm is bringing to your customers?
- iii. What kind customer relation is necessary to succeed in that case? (Partnerships?)
- iv. Online vs Offline data collection: needs, possibilities, risks.
- v. What kind of revenue model you use for this kind of services?

- vi. Which are the possibilities to keep the solutions up to date? (technical and human/cultural requirements)
- vii. What are the future possibilities in this area?
- viii. What are the problems, risks and constraints of these solutions?

*If not:*

- i. Do you think that lifecycle data management could be delivered by your company?
- ii. What would be the best way to sell these services?
- iii. What would be the problems, risks and constraints of these solutions?

## **5. Cloud services levels and possibilities**

- a) What kind of possibilities infrastructure as a service (IaaS) provides to maintain product functionality? And Platform as a service (PaaS)? And Software as a service (SaaS)?
- b) What is the role of engineering firm regarding cloud services? (rights and limitations)
- c) What is the role of software firm regarding cloud services? (responsibilities and limitations)
- d) How can these be sold effectively? (revenue model)
- e) Use of data: share or not? Implications.
- f) Regarding data privacy, how could the privacy is assured?
- g) Opinion on Benefits vs Risks of data shared on the cloud.

Do you have any suggestions or comments related to interview?